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August, 1960

The Mining Magazine

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The Mining Magazine

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CONTENTS

EDITORIAL

SALT reserves in this country of some 400,000 million tons have been revealed in the Cheshire Basin as the result of a deep boring campaign by the Geological Survey. A deep hole on a site about five miles from Whitchurch has proved a lower salt group which extends beneath about 400 sq. miles and an upper salt group beneath about 170 sq. miles of the Cheshire Basin with, in each case, a further undefined extension southwards. The reserves of salt which would reasonably have been computed from previous information have been at least doubled.

AT the iron-ore port of Luleå, on the coast of Bothnia, Luossavaara-Kiirunavaara AB (L.K.A.B.) has opened an exhibition mine as part of an exhibition celebrating the 150th anniversary of the incorporation of Norrbotten, the northernmost county in Sweden. It is in Luleå that L.K.A.B. is building a new port at a cost of Sw. Cr. 150,000,000, which, when completed in 1964, will be capable of handling ore shipments of up to 8,000,000 tons a year. The exhibition, a " drive-in " show, has been designed to give the appearance of the real thing, while an adjoining pavilion features a more conventional description in words and pictures of how ore is refined, dressed, and concentrated, with a model ore-train locomotive added for good measure. The pavilion also shows what L.K.A.B. is doing to make its operations more efficient and automatic.

SOUTHERN Rhodesia produced minerals to the value of approximately £25,000,000 in 1959, the gold output for the first time exceeding £7,000,000. In his review of the industry at the annual meeting of the Chamber of Mines of Rhodesia earlier this year the president, Mr. T. A. J. Braithwaite, referring to prospecting activity said that during the last 15 months exclusive prospecting reservations had been granted covering some 1,500 sq. miles under conditions requiring a minimum expenditure on exploration of nearly £400,000. One new copper mine was brought into production towards the end of 1957 and a second mine is now in the course of being developed, with a strong possibility of yet a third being established some 60 miles or so to the north-east of Karoi. In addition, the president said, there were reports of commitments to the extent of options having been granted over gold and nickel claims in some of the areas currently under investigation.

THE Council of the Institution of Mining and Metallurgy has elected Mr. A. R. O. Williams as President for the 1961–62 session. The president-elect was trained at the Royal School of Mines, where he took the metallurgy course from 1922 to 1926. After a few months in Magdeburg, working for Riley, Harbord and Law, he went to South Africa as a learner miner at Robinson Deep, thus beginning an association with New Consolidated Gold Fields unbroken except for a few short periods and war service. Further experience was gained at the Kansanshi mine of Rhodesia-Katanga Co., Ltd., in Northern Rhodesia, from 1930 to 1933, when Mr. Williams returned to England on his appointment as assistant to the chief engineer (then Mr. Robert Annan) at the London office of Gold Fields. While in this position he visited Yugoslavia and Victoria, Australia, and in 1938 his services were lent to the associated companies in Venezuela and America before he took up residence in Toronto as the company's engineer and representative in Canada. During the war Mr. Williams served in the Royal Engineers, advancing to the rank of Lieut.-Colonel and becoming C.R.E. Gibraltar and later C.R.E. 3rd Tunnelling Co., G.P., serving in France, Belgium, Holland, and Germany. For his services he was mentioned in despatches and awarded the O.B.E. In 1945 Mr. Williams rejoined New Consolidated Gold Fields as resident engineer in London. His work has entailed visits to mines in Europe and many parts of the African continent. He was later elected to the board of his company of which he is now a managing director. Mr. Williams became a Member of the Institution in 1944 and his service on the Council covers 15 years, from 1946 to the present time ; he was a vice-president during the period 1951–54. He was Chairman of the U.K. Metal Mining Association in 1957–58 and is a Member of Livery of the Worshipful Company of Drapers and a Freeman of the City of London.

EARLY last month the second brochure relating to the Seventh Commonwealth Mining and Metallurgical Congress to be held in Southern Africa in April–May next became available in this country. From this well illustrated and informative booklet it is

evident that plans have been well made to make this a memorable occasion. Commencing on April 10 there will be a series of technical sessions in Johannesburg with opportunities for visiting many of the Witwatersrand gold mines. Later visits will take in Natal and the Orange Free State goldfield. Tours available will also include Kimberley, Postmasburg, Klerksdorp, Rustenberg, and as far as Tsumeb in South-West Africa. After being centred on Johannesburg for 27 days the Congress moves to Lusaka, Northern Rhodesia, on May 7 to allow of visits to mines in the copperbelt and a week later it goes on to Salisbury, from which centre visits will be made to such places as Shabani, Bikita - Zimbabwe, Wankie, Selukwe, Que Que, Bulawayo, the Victoria Falls, and the Kariba Dam.

Open Days at Warren Spring

This year the Royal Society has been celebrating the tercentenary of its foundation and it was appropriate, in the circumstances, that Warren Spring, the newest of the Department of Scientific and Industrial Research's establishments, should have opened its doors to allow some of the visitors from overseas to see what goes on there. In planning this laboratory, opened by Lord Hailsham on June 29 last year, the Council for Scientific and Industrial Research devised a versatile station free to carry out research which cannot be fitted into the programme of any other research body, especially work involving pilot-scale investigations on subjects of national importance. Now, it seems, the laboratory's research programme includes a number of important investigations in several different fields. In chemical engineering, for example, the initial emphasis is on problems of mass transfer, while research on mineral processing is aimed primarily at improving techniques in the treatment of ores and minerals and developing profitable methods of exploiting hitherto unworked deposits. At the same time much research work is going on in the field of atmospheric pollution. The work at Warren Spring is reviewed in its annual report, published last month.[1] In it the Director, Mr. S. H. Clarke, outlines the progress of work in hand and from his account it is evident that promising developments are already receiving close study.

During a visit on the first open day last month it was revealed that among several investigations being carried out at the moment there are two considered of industrial importance. In the Mineral Processing Division work with naphthenic acids is developing a process with considerable economic advantage, while the Chemical Engineering Division's pilot-scale distillation plant is engineering facilities in dealing with certain problems urgent in modern industry. In regard to mineral processing it was pointed out that the successful development of new extraction processes for the recovery of uranium has raised the possibility of applying such techniques to the recovery of more common metals, although this will only be possible if cheaper reagents can be found to replace those used for uranium. The Division has therefore been examining the possibility of using commercial naphthenic acids for the extraction of metals such as copper, nickel, cobalt, zinc, and manganese. These acids, derived from crude petroleum oils, have extensive industrial uses, but have not previously been considered for the recovery of metals from aqueous solutions. Their cost, it is stated, is only about £130 a ton as compared with the price range of £640–£1,100 a ton for the alkyl phosphoric acids used in the recovery of uranium. It is certain that with many complex and low-grade ores the wanted metals can only be extracted by leaching and it is in the treatment of such leach liquors that naphthenic acids may have a possible use. The metals extracted by the reagent depend on the pH of the aqueous solution of leach liquors and it has been found, for example, that copper is extracted at pH 6, whereas nickel is extracted at pH 8. Thus by carrying out the extraction in two stages a separation of copper from nickel can be obtained. A further factor in the use of this technique, commonly referred to as liquid-liquid extraction, is, it is pointed out, that it can be used to obtain concentrated solutions of metals from very dilute solutions. In the Chemical Engineering Division the distillation column is now being used for research in conjunction with an automatic computer. With it, the laboratory has been studying methods for measuring the area of contact between gas and liquid on the distillation plate ; apparatus to measure the time taken by liquids passing across the plate is also being developed and the values of the mass-transfer coefficients are being measured by observing the rate at which dissolved gases are removed from a solvent by air passing through a distillation plate into the

[1] London : H.M. Stationery Office. Price 3s.

solution. All this it is believed may yet yield results likely immediately to be of benefit to industry.

In connexion with the work in progress at Warren Spring it is of interest that a report on a recent two-week conference of the British Commonwealth Scientific Committee was issued by the Department last month. This was held at the Administrative Staff College, Henley-on-Thames, and ended its work, it is claimed " on a note of close co-operation ". Mining men will be pleased to learn, in the words of the Department's communiqué, that an " important development is the formation of a Commonwealth Committee on mineral processing and the British Commonwealth Scientific Committee recognizes the importance of helping the younger independent nations in this type of co-operative research." From this, it is apparent, the facilities at the Warren Spring Laboratory may soon require expansion, for already its services are being sought increasingly by the mining industry itself.

A Notable Jubilee

Last month the United States Department of the Interior drew attention to the fact that the Federal Bureau of Mines, long regarded both in the United States and abroad as a leading authority on mineral conservation and development, became 50 years of age on July 1. The Bureau, it can be recorded, was created when coal-mine disasters were frequent. Since then safety research and training carried out by the Bureau and its co-operative efforts with labour and industry have been major factors leading to improved working conditions in all segments of the mineral industries. In the ten years before the Bureau began its work in a single research laboratory on the old Arsenal grounds in Pittsburgh coal miners died at the rate of 364 a year in major disasters. That yearly toll has now been reduced to 32 and impressive safety gains have been made in all activities concerned with the mining and processing of minerals.

It is a proud record that in half a century the Bureau has published nearly 8,000 reports describing its findings in research and development work on minerals, mineral fuels, and industrial health and safety. An equal number of articles has appeared in the scientific, trade, and technical Press. At the same time Bureau scientists have provided new metals such as titanium and hafnium and engineered other processes. In addition it has also added substantially to domestic supplies of mineral raw materials. Bureau pioneer studies of blasting, roof bolting, rock dusting, and other mining methods and practices have not only improved safety but have also increased efficiency in mines both in the United States and abroad.

The United States Lead Industry

In a recent Mineral Market Report [1] the United States Bureau of Mines discloses a domestic mine output of 255,600 tons of recoverable lead in 1959, the lowest in 60 years and 4% below the 1958 figure. The continuing decline is attributed to large lead-industry stock surpluses which accumulated because many smelters were closed by labour disputes. Consumption of lead in the United States was 11% above that of 1958 but about 12% below the peak year 1950. Of the total consumed 66% was soft lead, primary and secondary, 24% lead content of antimonial metal, 4% lead in alloys, 2% lead in copper-base scrap, 3·6% content of scrap, and 0·4% lead recovered from ore in the production of leaded zinc oxide and other pigments.

The research programme of the Bureau for lead and zinc during the fiscal year 1961, which began on July 1, will emphasize mining investigations covering basic and applied aspects of rock drilling and ground support and studies in extractive metallurgy. Other work is to be directed towards improving recovery procedures at secondary smelters, investigating and reporting on mining and milling costs at selected plants, and making statistical studies regarding metal supply and demand to help guide the intensity and character of industry and Government research. In the Cœur d'Alene region of Idaho the study of rock pressures and ground-support problems associated with deep mining will be continued. The effectiveness of precast, segmented, reinforced-concrete drive sets and the factors affecting hydraulic transportation and placing of stope fill are to be tested and theoretical concepts reviewed. Metallurgical work is to continue on the use of micro-organisms in extracting lead and zinc from marginal ores, the use of radioactive tracers in leaching studies, the reduction of sulphide minerals with atomic hydrogen, and the concentration of slimed sulphides by flotation.

[1] MMS No. 3093.

MONTHLY REVIEW

Introduction.—International uncertainties created by the course of events in the Congo may be allayed somewhat by the news that United Nations security forces are to be allowed into the Katanga province. Commodity prices, sustained by the general high level of productivity in industry, remain firm, although metal prices show little change over the past month.

Transvaal.—The gold output figures for the Rand and Orange Free State mines for June show a production of 1,775,335 oz., making with 37,530 oz. from outside mines a total of 1,812,865 oz. for the month, another record. At the end of the month there were 380,593 natives at work in the gold mines, as compared with 383,212 at the end of May.

Last month shareholders of WESTERN DEEP LEVELS were informed that two underground bore-holes drilled for structural information on 68 level within a radius of 170 ft. of No. 3 Main Shaft had intersected the Ventersdorp Contact Reef—No. 1 bore-hole at a depth of approximately 6,349 ft. and No. 2 at approximately 6,397 ft. from surface. No. 1 bore-hole showed 4·98 dwt. of gold per ton over a true width of 78·8 in., and No. 2, 44·59 dwt. of gold per ton over a true width of 53·2 in.

In the June quarter MESSINA (TRANSVAAL) DEVELOPMENT produced 249,000 tons of ore containing 3,452 tons of recoverable copper.

Orange Free State.—As is noted by our South African Correspondent elsewhere in this issue information now obtained regarding the position of the reef in an area remote from No. 1 shaft at FREE STATE GEDULD MINES has led to a decision to sink a companion hoisting shaft adjacent to No 1A Ventilation Shaft for the more rapid and more economic development and exploitation of the area. No. 1A Ventilation Shaft should be commissioned at the end of this year, as originally planned, to serve primarily as a ventilation shaft with facilities for hoisting a limited amount of development tonnage. This will enable development to be undertaken to the vicinity of the new hoisting shaft. Stations and ore-pass systems are to be cut so that the new shaft can be brought into full production as soon as possible after sinking and equipping has been completed. With the commissioning of the new hoisting shaft the No. 1A Ventilation Shaft will be converted to complete upcast conditions thus ensuring adequate ventilation for the whole of the western section of the lease area. The hoisting shaft is to be 24 ft. in diameter and will be sunk to approximately 5,000 ft. The capital expenditure involved in the sinking and equipping of the proposed shaft, in the provision of the necessary surface buildings, including native accommodation and rail transport to the reduction plant, is estimated at £2,900,000, which will be financed out of profits, it is stated.

WESTERN HOLDINGS is also to sink a new shaft—a ventilation upcast shaft adjacent to the No. 1 Hoisting Shaft, which is to be converted to complete downcast. This will have the effect of almost doubling the ventilation available in the No. 1 Shaft Area, which in turn will make possible, without affecting production, the exploitation of the deeper levels west of the Dagbreek Fault and the prospecting of the area eastward and beyond the Fault. It will also enable development to be undertaken in the north-western sector of the mining lease area in the vicinity of Bore-hole FH. 2. The new shaft, to be taken down to 4,500 ft., is to be 20 ft. in diameter and it is anticipated that additional ventilation from this shaft will become available during 1962. The cost of sinking the shaft and the provision of the ventilation plant, estimated at £800,000, will be financed out of profits.

At an extraordinary meeting of FREE STATE SAAIPLAAS GOLD MINING, to be held in Johannesburg on August 17, it is to be proposed that the capital of the company shall be increased to £14,000,000 by the creation of 6,000,000 new 10s. shares. As is noted elsewhere in this issue the new shares are to be allotted at par to a syndicate under the leadership of the CONSOLIDATED GOLD FIELDS OF SOUTH AFRICA. Milling is expected to begin at the mine in October next, but additional finance is required to maintain operations, while to make the best use of payable tonnage resources in the mine it has been decided to equip it for production at a milling rate of 100,000 tons per month.

Southern Rhodesia.—In the three months to June 30 last M.T.D. (MANGULA) milled 304,900 tons of ore and recovered concentrates estimated to contain 3,305 tons of copper.

Northern Rhodesia.— The report of NCHANGA CONSOLIDATED COPPER MINES for the year ended March 31 last shows a profit of

£13,643,764 and £14,494,970 available for appropriation. Dividends equal to 7s. a share require £9,800,000. In the year under review 4,357,100 short tons of ore was milled and 178,045 long tons of copper produced (148,717 tons electrolytic). The ore reserves at the property are estimated at 180,019,000 tons averaging 4·65% copper. In his review accompanying the report and accounts the chairman, Mr. H. F. Oppenheimer, states that the consulting engineers to the company have been examining proposals designed to improve extraction. The two open pits yield oxidized ores, while the ore mined underground is in sulphide form, most of the sulphides being treated at the Rhokana smelter and most of the oxides at the leach plant. A scheme for installing improvements and extensions at the leach plant which could result in more efficient extraction is being investigated. In addition it is thought that the efficiency of the Rhokana smelter could be improved by diverting some concentrates to the leach plant. Preliminary estimates indicate that the cost of the extensions required would be between £2,000,000 and £3,000,000 and it is hoped that it will be possible in this way to produce an additional 15,000 tons of copper a year without increasing the rate of mining. More detailed technical investigations are in hand.

Last month the British South Africa Company announced that its estimated gross revenue from mineral royalties, rents and fees for the quarter ended June 30, after providing for the payment to the Northern Rhodesia Government of 20% of the net revenue derived from the exercise of its Mineral Rights in Northern Rhodesia, amounted to £3,025,000.

Nigeria.—The operations of Naraguta Karama Areas for 1959 resulted in a profit of £2,810, the accounts showing £4,897 available for appropriation. After making various allowances a credit balance of £1,863 is carried forward. Operations on the Wamba areas were resumed in August, 1959. Tin ore production for the year from the combined areas amounted to 82·59 tons, compared with tin ore permitted exports totalling 98·28 tons, but shipment of the latter tonnage was fulfilled by the despatch of 15·69 tons from permissible mine stock.

Tanganyika Territory.—In the year to March 31 last Kentan Gold Areas made a profit of £166,816, the accounts showing £761,807 available, of which dividends equal to 3s. 6d. a share require £142,916. In the financial year Geita Gold Mining milled 231,880 tons of ore and recovered 43,615 oz. of gold for a working profit of £47,555. Ore reserves at Geita are given as 995,000 tons averaging 4·1 dwt. in value. Geita's progress report for the June quarter shows 62,100 tons milled for 10,870 oz. and a working profit of £5,291.

Australia.—In the six months to June 30 last, Mary Kathleen Uranium milled 221,000 tons of ore and produced 758,000 lb. of uranium oxide. The gross revenue for the period is given as £A3,365,186 and the profit as £A910,145.

Following an industrial dispute at the mines of the Zinc Corporation and New Broken Hill Consolidated last month normal operations were resumed on August 8, pending further discussions between the companies and the employees.

Gold Mines of Kalgoorlie (Aust.) reports a profit of £A323,869 for the year ended March 31 last. Dividends paid in the year required £A202,265.

Shareholders of the Western Mining Corporation have been informed that drilling on the bauxite leases of Western Aluminium N.L. to date indicates reserves of 37,000,000 tons of bauxite containing 44% Al_2O_3; of this amount 13,000,000 tons could be mined at 47% Al_2O_3. The bauxite has satisfactory chemical and physical characteristics, it is stated, all Al_2O_3 being in the easily treated tri-hydrate form. Reactive silica content is low and the filtering and settling characteristics of the residues from the dissolution of the bauxite are good. The area drilled so far is a minor part of the area known to contain bauxite, it is stated, and drilling continues to give satisfactory results. Samples of bauxite have been submitted to three aluminium producers in Japan and their laboratory tests have indicated that the bauxite could be treated in their plants. In April the Western Australian Government approved the mining and export to Japan of bauxite from the company's leases and initially authorized the export of up to 1,250,000 tons during the next five years.

At the annual meeting of Sons of Gwalia held in Perth last month the chairman reported that during 1959 development work totalled 4,429 ft., an increase of 1,048 ft. over 1958, and 2,804 ft. more diamond drilling was carried out. The development of the Hanging Wall series, he said, is still bringing in further reserves of above average grade ore, and new work on the West Lode on the No. 12

Level and above has been very promising. Generally, he thought, it might be said that development results have been encouraging.

New Guinea.—In the year to May 31 last BULOLO' GOLD DREDGING treated 5,726,623 cu. yd. of ground and recovered 22,839 oz. of gold. An increased yardage handled by Dredge No. 5 with increased throughput at the Widubosh sluicing operation resulted in an increase in the gross value for the year. The estimated net profit from the operations in New Guinea for the year is given as $470,000 after allowing for tax. The company has, in addition, received dividends from COMMONWEALTH-NEW GUINEA TIMBERS LTD., and PLACER DEVELOPMENT, LTD., during the year amounting to $405,100.

Malaya.—A recent circular to shareholders of RAUB AUSTRALIAN GOLD MINING reviews progress to April 23 last, in which period 10,325 tons of ore was crushed and 2,875 oz. of gold recovered. It is stated that results from mining and development underground continued to be disappointing and that although the cyanide plant for re-treatment of pyrite re-commenced operations in February, 1960, it had to be temporarily stopped in April owing to shortage of mineral. The re-treatment plant for production of pyrite and scheelite has been extended and is now operating satisfactorily. Pyrite production is now approximately 2 tons per day, which is sufficient to permit the cyanide plant to run continuously.

At the annual meeting of GOPENG CONSOLIDATED last month shareholders were informed that the purchase of the assets of the FRENCH TEKKAH MINES was completed and possession taken of the property on April 1, 1959. Plans were immediately put into operation for the re-organization of the system of work on the property and for the necessary repairs to power stations and transmission lines to ensure maximum power being available for mining operations and to comply with the Electricity Regulations. An extensive boring programme was also commenced on the newly-acquired leases and substantial ore reserves have been proved at the Jelantoh Section.

A recent circular to shareholders of HONGKONG TIN states that improving market conditions and the likelihood that quota releases will be progressively increased justify the re-starting of the dredge and the general managers have been instructed accordingly. It is anticipated that dredging operations will recommence about the middle of September.

SUNGEI KINTA TIN DREDGING has announced that results for 1959 show a net profit of £14,479, against a net loss of £4,481 for the previous year. The profit of £14,479 is before transfer to general reserve of £3,000 and special provision for depreciation of dredge spares £11,144.

TRONOH MINES shareholders have been informed that the offer to purchase the shares of SOUTHERN TRONOH TIN DREDGING is now unconditional, having been accepted by holders of over 77% of the issued shares other than the shares held by Tronoh Mines.

United Kingdom.—With the recent dividend notice shareholders of GEEVOR TIN MINES were informed that the profit for the year to March 31 last was £75,362, as compared with £89,731 for the previous year.

It was stated last month that the U.K.A.E.A.'s beryllium works at Milford Haven, which have been operated on an agency basis by MUREX, LTD., have been sold to CONSOLIDATED BERYLLIUM, LTD., who will take over the works on September 8 and continue the operations on a reduced scale. Consolidated Beryllium has also beryllium operations at Avonmouth, near Bristol. It is managed by the IMPERIAL SMELTING CORPORATION, who have 50% ownership, the other 50% partners being BERYLLIUM CORPORATION OF READING, Pennsylvania, U.S.A. The Imperial Smelting Corporation is a wholly-owned subsidiary of the CONSOLIDATED ZINC CORPORATION, LTD.

Canada.—An interim report by DENISON MINES, covering the period to June 30 last, shows an output valued at $28,022,000 and a profit of $10,482,000. The company was formed on March 24 last by amalgamating CONSOLIDATED DENISON MINES and CAN-MET EXPLORATIONS and the present report, the company president says, is intended, in view of the " somewhat unsettled state " of the uranium industry, to acquaint shareholders with all the important facts pertaining to the undelivered balance of the guaranteed contract for the sale of uranium oxide to ELDORADO MINING AND REFINING. At June 30, 1960, the company had an undelivered balance against this firm contract of approximately $134,000,000, scheduled for delivery over a 3½-year period from July 1, 1960, to December 31, 1963. To secure the lowest possible production costs and to take maximum and proper advantage of its tax-free status until December 31, 1960, the company is at present producing at capacity. This involves some stockpiling and explains

the fact that the June 30 inventory was approximately $17,000,000, as compared with $6,000,000 at the same date a year ago.

Shareholders of PLACER DEVELOPMENT have been informed that the consolidated net profit with that of its wholly-owned subsidiary companies, subject to audit and year-end adjustments, is estimated at $1,250,000 for the year ended April 30, 1960, as compared with $1,152,000 for the previous year. The consolidated earned surplus, it is stated, was further increased during the year by approximately $9,000,000, resulting from the sale in July, 1959, of the whole of CORONET OIL COMPANY's common shares held by Placer Development. It is expected that a large amount of the funds resulting from this sale will be required for development of the several large mining ventures.

Consolidated Tin Smelters.—The consolidated profit of Consolidated Tin Smelters for the year to March 31 last is £522,427 after providing £436,382 for taxation. Tax credits not attributable to the year amount to £19,005, giving a surplus of £541,432, of which £324,524 is dealt with in the accounts of the holding company. A dividend equal to 3s. 6d. and a bonus of 6d. requires £214,211, the only other appropriation being £50,000 to general reserve.

Johannesburg Consolidated Investment Company.—With the recent dividend notice shareholders of the Johannesburg Consolidated Investment Company were informed that, subject to audit, the profit for the year ended June 30 last, is £2,099,653, after taxation. With the sum brought in there is £2,342,875 available. Of this amount £1,203,000 is placed to reserve, while £898,333 is required for dividends equal to 5s. a share, leaving £240,639 to be carried forward.

London Tin Corporation.—The consolidated accounts of the London Tin Corporation and its wholly-owned subsidiaries for the year to March 31 last show a profit of £619,151, making with the sum brought in an available total of £1,322,306. Dividends equal to 25% require £554,042, leaving £768,304 to be carried forward.

DIVIDENDS DECLARED

*Interim. †Final.

(Less Tax unless otherwise declared).

***Ashanti Goldfelds Corporation.**—1s., payable Sept. 13.

***Ayer Hitam Tin Dredging.**—1s. 3d., payable Aug. 18.

***Bibiani (1927).**—2·4d., payable Sept. 13.

***Borax (Holdings).**—Def. ord. 3%, payable Sept. 9.

***British Tin Investment Corporation.**—7%, payable Aug. 24.

Capper Pass and Son.—*3% and †3%, payable Aug. 3.

***Consolidated Mines Selection Co.**—1s., payable Aug. 25.

†Consolidated Tin Smelters.—3s., and 6d. bonus, payable Sept. 13.

Denison Mines.—$1·00, payable 50 cents on Aug. 15 and 50 cents on Dec. 15.

†Geevor Tin Mines.—2s.

***Gopeng Consolidated.**—6d., payable Aug. 27.

***Idris Hydraulic Tin.**—4½d., payable Aug. 12.

***International Nickel Co. of Canada.**—37½ cents, payable Sept. 20.

†Johannesburg Consolidated Investment Co.—5s., payable Sept. 22.

***Kent (F.M.S.) Tin Dredging.**—3d., payable Sept. 2.

†Kentan Gold Areas.—10%, payable Sept. 30.

***Konongo Gold Mines.**—1d., payable Sept. 16.

***Mary Kathleen Uranium.**—1s., payable Aug. 25.

†Murex.—12½% and 2½% bonus, payable Sept. 30.

†New Central Witwatersrand Areas.—4½d., payable Aug. 29.

Pahang Consolidated Co.—Pref. 3½%, payable July 30.

***Pengkalen.**—3d., payable Aug. 19.

†Puket Tin Dredging.—15%, payable Aug. 15.

†Selukwe Gold Mining and Finance.—5%.

***Sungei Besi Mines.**—3d., payable Aug. 16.

***Tanjong Tin Dredging.**—1s., payable Aug. 20.

***Tronoh Mines.**—1s. 3d., payable Aug. 10.

***Zaaiplaats Tin Mining Co.**—1s. 4½d., payable Sept. 9.

METAL PRICES

Aug. 9.

Aluminium, Antimony and Nickel per long ton; Chromium per lb.; Platinum per standard oz.; Gold and Silver per fine oz.; Wolfram per unit.

	£	s.	d.
Aluminium (Home)	186	0	0
Antimony (Eng. 99%)	190	0	0
Chromium (98%–99%)		7	2
Nickel (Home)	600	0	0
Platinum (Refined)	30	5	0
Silver		6	7¼
Gold	12	10	0¼
Wolfram (U.K.)		—	
(World)	7	19	0

Tin, Copper, Lead, Zinc } See Table, p. 112.

Solvent Extraction Techniques

Chemical processing of leach liquors now widely applied

W. H. Dennis, B.Sc., M.I.M.M.

Introduction

Solvent extraction as a means of separation and purification has for long been familiar to the chemical industry. Refining of lubricating and vegetable oils, the processing of pharmaceutical compounds such as the antibiotics, penicillin and streptomycin, and the recovery of acetic acid from dilute aqueous solutions are but a few examples of the many processes which employ the method at one stage or another during the course of manufacture or refining. Only in recent years, however, has it begun to achieve wider recognition in the metallurgical field as a means of recovering metals in solution selectively.

Among the factors which have contributed to this trend are :

(1) A need to replace the older and more complicated treatments for the separation and recovery of the rarer metals, particularly those in demand for atomic energy purposes.

(2) The increased emphasis on the treatment of low-grade ores by hydrometallurgical processing.

The procedure has been of particular value in uranium extraction and offers the advantages, as opposed to ion exchange, of simplicity, speed, continuous operation, and wide scope. From a practical standpoint the object of solvent extraction (also referred to as liquid-liquid extraction) is to purify or remove unwanted substances from a component and to transfer it to an environment more suitable for isolation. The method is based upon the use of an immiscible solvent in which the component(s) is (are) preferentially dissolved. If an appropriate organic solvent is intimately mixed with an aqueous solution and allowed to settle the substances present will distribute themselves between the organic and aqueous media depending on the relative solubility in the two phases. The component(s) with the greatest solubility in the organic solvent will tend to diffuse into this phase and thus a separation of the components originally present in the aqueous solution can be achieved. As the volume of solvent employed is considerably less than that of the aqueous solution a concentration or enrichment of the component takes place.

After the desired component has been extracted into the organic phase it is usually necessary to back extract into an aqueous phase for further processing. The process known as stripping (Fig. 1) regenerates the solvent which is recycled for further use.

Solvent Characteristics. — The primary requisite of the organic solvent is that it must be highly selective for the desired components which are to be transferred. Chemical stability is necessary and a marked

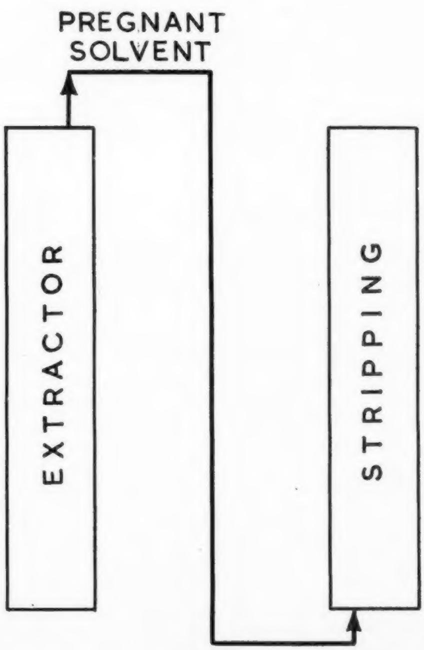

Fig. 1.

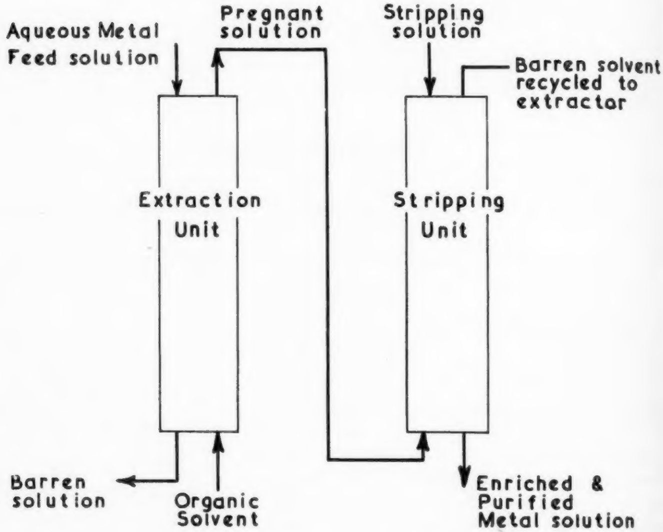

Fig. 2.—Schematic Flow-Sheet.

specific gravity difference between organic and aqueous phase is essential in order to allow of ready separation. Viscosity of both phases must be low in order to avoid emulsification. Finally, there must be good recovery of the solvent. Organic extractants which have been found most successful in metal recovery are the ketones and esters formed by the reaction of phosphorus pentoxide with straight or branched chain alcohols.

Equipment.—The method of solvent extraction involves :—

(1) Mixing the solvent and the aqueous solution containing the metal to be extracted.

(2) Separation of the resulting phases.

(3) Removal and recovery of the solvent and the component extracted.

The equipment selected for bringing the two liquids into intimate contact is commonly of two types differing mainly in the means effected to achieve contact between the two phases. In the mechanical type as exemplified by that used in the extraction of uranium from its ores (Fig. 2) the mixer-unit consists simply of an impeller or a ship-type bladed propeller mounted in a steel tank. Separation takes place either in the same tank or in a separate settler tank. The other type (Fig. 4) consists of vertical columns 60–80 ft. high, the two liquids being introduced at opposite ends of the columns and mixing ensured by the employment of metallic or ceramic packing material or by the provision of a perforated sieve plates spaced at intervals in the column, the perforations serving to break up the liquids into droplets thus ensuring intimate contact. Efficient mixing in the column can also be effected by pulsations transmitted to the liquids by the reciprocating motion of a pump piston, each pulse of increased pressure being followed by a corresponding suction pulse. Separation of the two phases takes place at top or bottom of the column in suitably provided settling vessels, the interface level being maintained by regulation of the ratios of flow of the two phases to the column. In both cases a number of units are employed, so arranged that the counter-current principle can be employed, with one liquid flowing in one direction and the other in the opposite direction.

Application.—Typical of the developments which have occurred in recent years in the field of metal solvent extraction are the recovery of uranium from its ores, the separation of hafnium from zirconium, and plutonium from uranium. These are briefly reviewed.

Uranium Recovery

The method (Fig. 3) is generally applicable to ores containing uranium in the form of acid-soluble uraninite, autunite, and carnotite minerals. The ore is wet ground and passed to the leaching circuit, where the uranium is treated with sulphuric acid. The leached residues are then separated from the uranium

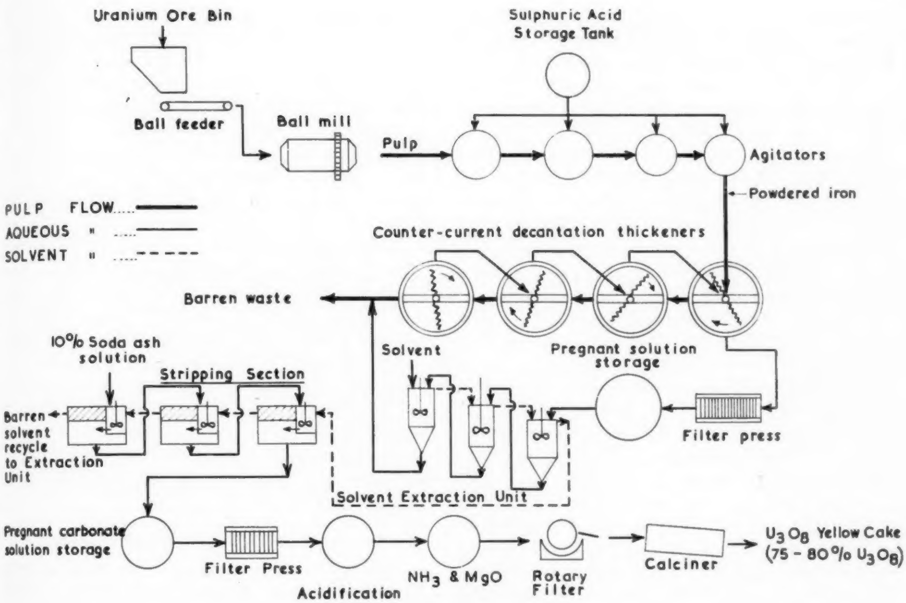

Fig. 3.—Uranium Extraction.

pregnant solution in a counter-current decantation system, the uranium in the clear pregnant liquor then being extracted by contact with an organic solvent, the impurities being left behind in the liquor. Uranium is then stripped from the solvent and precipitated. It is to be noted that uranium is only a very minor constituent of the solution, the bulk of the dissolved substance being iron, aluminium, manganese and magnesium sulphates, which are present to an extent of approximately 200–300 times that of

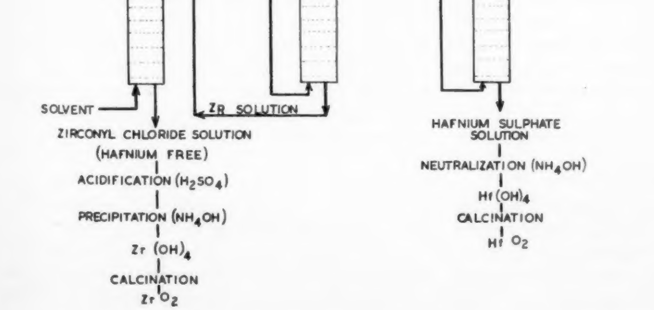

Fig. 4.—Separation of Zirconium and Hafnium.

uranium. The continuous selective extraction of the uranium by the solvent is thus one of the major advantages of the process.

The solvents used are generally of the organo-phosphate type, dialkyl-phosphoric acid being commonly employed. As the solvent is too viscous to be employed alone it is dissolved in kerosene, which thus acts as a carrier. Long chain amines have been considered, for uranium can be more easily stripped and they are more stable and slightly more selective. Further there is no necessity to reduce ferric iron to ferrous as is the case when using alkylphosphoric solutions. The latter are, however, available at about one-third of the price of amines.

Crushing and Leaching.—The ore containing 0·20–0·50% U_3O_8 is crushed to ½ in. and wet ground in a ball-mill to *minus* 20 mesh. The ground ore at 50–60% solids is agitated 12–16 hours in a series of acid-resistant tanks, rubber-covered cast-iron turbine blade paddles being used to provide agitation to maintain the ore particles in suspension. Sulphuric acid is stage added to maintain a pH of 1·0, the average total of acid used being about 200 lb. per ton of feed. Manganese dioxide is added as an oxidant to increase uranium dissolution and iron powder to reduce ferric to ferrous iron. Leached residues are separated from the uranium-bearing pregnant solution by counter-current decantation in thickeners. The underflow solids are pumped by diaphragm pumps with the final underflow going to waste. The Stage 1 thickener overflow, containing about 1 g. U_3O_8 per litre, is pumped to the solvent extraction plant. Settling reagents are generally added to promote flocculation and the production of clear solutions.

Solvent Extraction.—The equipment consists of mixer-settlers with solvent passing counter current to the flow of pregnant acid solution. Thickener overflow passes to the first extractor and is pumped between units, the barren solution from the final stage going to waste. Solvent is introduced to the last unit and after mixing collects at the surface of the solution overflowing from one stage to the next. The solvent having a greater affinity for the uranium than the aqueous sulphate solution the metal is transferred to the organic phase.

The limiting operational factor is mainly the rate at which the aqueous phase settles from the organic phase. Operation above a certain limit can result in emulsification and hence lead to solvent by-passing with resultant losses. Normal solvent loss is about 0·5 gal. per 1,000 gal. of pregnant solution.

Solvent Stripping.—In this section mixer-settler units are utilized in counter-current flow much the same as in the extraction section. The pregnant organic solution is introduced to the No. 1 stripping mixer and 10% soda ash solution to the last mixer, advancing counter current by means of air lifts. The soda ash having the greater affinity for uranium the latter is separated from the organic solvent and joins the soda ash solution. Stripped solvent from the last unit is recycled to the extractor unit to contact further pregnant solution. The soda ash solution, containing approximately 40–60 g. per litre of uranium, is filtered, the pH adjusted to 3·0 with sulphuric acid, and magnesia and ammonia added to precipitate uranium, which after filtering and drying emerges as a yellow cake assaying 75–80% U_3O_8.

Separation of Hafnium from Zirconium

Hafnium occurs in nature associated with zirconium in all zirconium minerals, zircon (ZrO_2SiO_2) the commercial mineral containing 0·1% to 2·0% hafnium. Hafnium possesses a very high neutron absorption cross section and for nuclear reactor purposes it is therefore necessary to free zirconium—which possesses a low neutron absorption characteristic—from contamination by this element. Hafnium and zirconium probably resemble each other more closely than do any other two elements and because of this intimate relationship the method used to decompose zircon will at the same time free hafnium. It has been reported that the separation may be accomplished by the fractional distillation of mixtures of hafnium zirconium chloride—phosphorous oxychloride and by fractional crystallization of the mixed zirconium-hafnium fluoride-potassium fluoride double salts. The separation on a plant scale is, however, now operated by solvent extraction, the raw materials being the mixed tetrachlorides of the metals, the solvent used being isobutyl methyl ketone (containing thiocyanic acid) which selectively extracts the hafnium.

Preparation of Tetrachlorides.—Zircon and carbon are first briquetted and heated in an electric-arc furnace to 1,100° C. Chlorination of the crushed carbide takes place in a vertical shaft furnace lined with silica brick heated to 500° C. Zirconium and hafnium tetrachlorides pass off and collect as a light

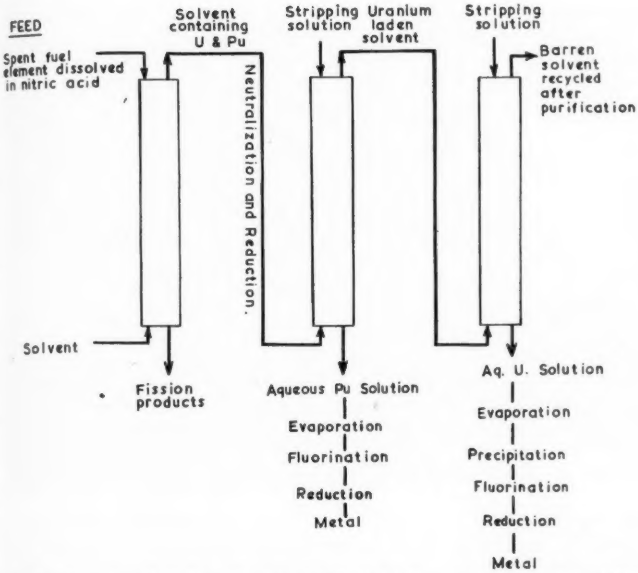

Fig. 5.—Recovery of Uranium and Plutonium.

powder in a condensing chamber attached to the furnace. The crude chlorides are then freed from contaminating iron and silicon chlorides by volatilization in the presence of hydrogen.

Extraction Unit.—Zirconium tetrachloride containing the hafnium is dissolved in hydrochloric acid and ammonium thiocyanate added and passed counter current in columns to the solvent, which extracts the hafnium *plus* about 25% of the zirconium. The aqueous solution leaving the bottom of the column is substantially hafnium free (Fig. 4).

Stripping Unit.—The organic stream from the extractor goes to a stripper column, passing counter current to a hydrochloric acid solution which strips the zirconium from the solvent, the zirconyl chloride being recycled back to the extraction unit. The solvent from the stripper enters a scrubber unit where the hafnium is removed by a sulphuric acid solution. After adjustment of the thiocyanate content the solvent is recycled back to the extraction unit.

Zirconium Recovery.—Aqueous solution from the extractor is mixed with sulphuric acid to obtain a ratio of 2·5 Zr : 1 H_2SO_4 and, on adjusting to a pH of 1·4 with ammonia, zirconium precipitates as the hydroxide. It is filtered off, dried, and calcined at 800° C. to yield pure zirconium oxide.

Hafnium Recovery.—The aqueous hafnium sulphate solution from the scrubber is neutralized with ammonia and the pH adjusted to 9–10, hafnium precipitating as the hydroxide which is filtered off, dried, and calcined to the oxide. The separate oxides can then be reduced to metal by the Kroll process which involves chlorination of the oxides and reduction with magnesium metal.

Hafnium, once a mere name in the periodic table, has several properties of industrial interest and, with supplies now becoming available, the metal and its compounds can possibly become a useful marketable commodity. The metal possesses a specific gravity of 13·3 and a melting point of 1,975° C., is strongly resistant to corrosion, and has good strength and ductility. Possessing a high neutron capture characteristic it is of potential interest as rod material in controlling nuclear reactors. The oxide is a valuable insulator for very high temperature work and also a possible raw material for high-temperature ceramics, while the carbide makes a compound with tantalum carbide which possesses the highest recorded melting point for ceramics (3,942° C.). Hafnium boride has exceptional electrical conductivity.

Separation of Plutonium and Uranium

Plutonium is formed in nuclear reactors as a by-product resulting from absorption of neutrons by uranium 235. In addition a large number of radioactive isotopes are produced from the fission process itself, which tend to

slow down the process, so that the amount of fissionable material remaining in the reactor falls below what is needed to maintain the chain reaction. The spent fuel is then removed from the reactor, the uranium separated from the plutonium and fission products and so made available for re-use as fuel. Plutonium is converted to metal for military use or as an alternative fuel for advanced-type reactors.

The technique (Fig. 5) for processing the spent fuel involves dissolving the uranium and extracting it with the plutonium into an organic solvent, from which uranium and plutonium are subsequently recovered separately. The process depends largely on the variable valency of plutonium, the hexavalent form being soluble in the organic solvent whereas the trivalent form is almost insoluble. Dibutyl carbonyl or tri-n-butyl phosphate are employed as the organic solvents.

The spent fuel rods which contain about 0·05% plutonium are stored in water for several weeks to allow decay of the short-lived products of irridation. After dissolving in nitric acid and diluting both uranium and plutonium are extracted by the organic solvent, the fission products remaining in the aqueous phase. Neutralization of the acid followed by addition of ferrous sulphanate reduces the plutonium to the trivalent state which can then be stripped from the solvent using ammonium nitrate. Uranium which remains in the organic phase is stripped with dilute acid, concentrated and purified by further solvent treatment, and processed to metal. The plutonium in aqueous solution is oxidized with sodium dichromate, purified by repeating the extraction, concentrated by evaporation, and then converted into fluoride and reduced to metal with metallic calcium.

Packed vertical columns are used as contactors for the solvent extraction and although simple in construction are in some cases 80 ft. high and contained in concrete walls as protection against radioactivity. Control of operation is exercised by instruments installed in the columns, such data as concentration of uranium, etc., and the level of radioactivity being continuously transmitted to control stations situated in an area remote from the plant, adjustment of operations being performed by flow controllers.

Conclusion

Uranium recovery represented the first use on a large scale of solvent extraction in the metallurgical field and as a result it is now being employed in many countries not only for the extraction of uranium from low-grade ores, but also for the selective separation of many other metals which formerly required prolonged and cumbersome chemical treatments for their isolation. The major difficulties have been resolved and the present applications mentioned in this brief article represent but a few examples of this rapidly increasing technique.

The Non-Radioactive Minerals of the Tambane District, Nyasaland

Mineralization in the surroundings of the Mwanza Fault

V. L. Bosazza, D.Sc., M.I.M.M.

Introduction

The author has already described the radioactive minerals of this area in the most south-westerly part of Nyasaland in a previous article,[1] in which some reference was made to the host rocks. The Geological Survey of Nyasaland has prepared a publication dealing in detail with the geology and economic geology of the area, illustrated by means of a number of maps of the deposits.

The chief non-radioactive minerals discussed here occur to the west of Tambane, along or west of the Basement Complex-Nepheline Syenite Complex and consist of brown and blue corundum, columbite, ilmenite, magnetite, and microscopical pyrite, with some molybdenite, near Chikoleka village

[1] A list of references is given at the end of this article.

Fig. 1.—Corundum in Gneiss.

and in the Supe River near Tambane market. Some garnet occurs near Boundary Beacon 38 E, just west of Chimelango village. Another occurrence of massive garnet occurs just north-east of the Laaks Camp Road where it crosses the Ngona River. The present article, however, deals mainly with corundum and magnetite-columbite.

The corundum is not a constituent of the nepheline syenite ; it is, in fact, much older than the process of nephelinization. Cooper (1946) has considered that the corundum reefs have been intruded as plumasitic or corundum-bearing pegmatites, but in fact the field work shows very little evidence of this and holds the view that the highly aluminous metamorphic rocks are more probably of sedimentary origin. The Tambane corundum-bearing rocks are unlike the plumasitic rocks examined from the Transvaal.

Corundum, zircon, and ilmenite-magnetite have been found on the eastern side of Tambane in the Tambane Complex and in the western area far from nepheline syenites. Corundum is not confined to the nepheline syenite and in fact that rock very rarely contains corundum although zircon occurs in it, usually as minute grains but also in crystals up to a centimetre long. The main corundum occurrences are along the western slope of Ntondwe, the more westerly range of nepheline syenite in the Tambane mass. Although corundum occurs in very coarse-grained rocks that may be called pegmatites they also occur in smaller crystals in the feldspathic gneisses near the village of Sigulane. It is here too that Mr. J. H. M. McNaughton drew attention in 1956 to a corundum crystal corroded by nepheline. This is in the long apophysis shown on Cooper's map. It is doubtful, therefore, whether the corundum has any connexion with the process of nephelinization, which in this case, unlike Salambidwe, appears to be caused by some form of hydrothermal alteration, the syenite being hot magmatic in origin.

In Fig. 1 a specimen from Sigulane's village shows the zoning around a corundum crystal of nepheline which is quite common in this particular area, where the blue form of corundum (sapphire) also occurs. In one slide the corundum occurs in an elongated growth with non-uniform extinction and is immediately surrounded by fresh orthoclase. The surrounding rock consists chiefly of microcline and albite but there is associated with it a fresh green biotite, the latter also often in contact with the corundum (Fig. 2). The biotite is often surrounded by a colourless muscovite with medium bi-refringence. There is little or no quartz in this rock. It can be noted that the orthoclase surrounding the corundum has an irregular contact across the cleavage of the albite, but in general the corundum conforms to the gneissosity of the rock.

Harker has considered the thermal metamorphism of aluminous and ferruginous sediments into corundum-bearing rocks (1939). Cooper (1946) considered that the corundum deposits of Tambane fall into two classes,

(*a*) magmatic and (*b*) plumasitic, the first grading into the second. Starting off with pelitic sediments this worker considered what processes are necessary to reach the present composition. The plumasites he considers to be intrusive. Many of Cooper's observations on the occurrence of corundum and zircon require modification in the light of the extensive trenching and some winzing carried out since. For example, the corundum is usually not associated with zircon, contrary to Cooper's opinion, and most of the zircons in the main Eastern Tambane and Ntondwe Ranges are not associated with corundum at all. Along the foot of the Ntondwe Range (Western Tambane) the corundum is associated just to the north of the east Camp with some allanite. Owing to poor exposures it might easily be taken that the zircons and corundum are closely associated, particularly in the old workings to the south of Chikoleka Village, but extensive trenching has shown that the zircon-betafite zone is distinct from the corundum coarse-grained rocks and also from the very radioactive mineralization in which monazite, allanite, zircon, columbite, uraninite, molybdenite, and other sulphides have been found.

No zircons have been noted along the Sigulane pegmatite, which runs through the Boundary Beacon 38 C. Starting from the north end of this pegmatite, monazite is found replacing the pegmatite along the joint planes and around the beacon there are radioactive minerals of the betafite-samarskite type, not only replacing the pegmatite but also the gneisses on either side of the pegmatite. To the south of Beacon 38 C, near Sigulane school, the pegmatite divides in two separated by about 50 ft. to 60 ft. and in the gneiss in between there is both blue and brown corundum, of which one specimen has been described. A few hundred feet south of Beacon 38 C nepheline has replaced the rock along the gneissosity in a manner suggesting hydrothermal penetration rather than magmatic. The zone of nepheline has not a distinctive outline; it is more in the nature of highly irregular veins rather than dykes.

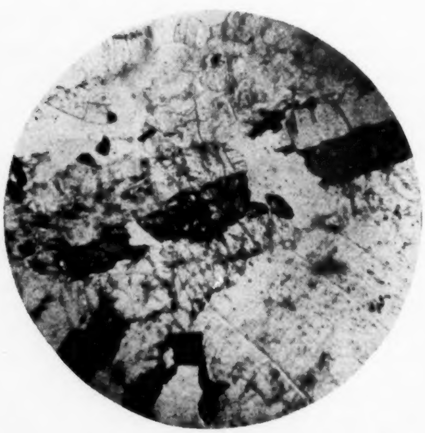

Fig. 2a.—Corundum in Gneiss from the Sigulane Pegmatite (× **22**).

Fig. 2b.—Corundum Laths with Biotite (× **22**).

The evidence of this deposit as well as others suggests that the process of formation is much more simple than that considered by Cooper and the author considers that these corundum zones were simply aluminous sediments poor in silica which have been metamorphosed into feldspathic gneisses. For example, Coetze has considered that a sillimanite-corundum rock in Namaqualand was simply a metamorphosed bauxite (1941). Similarly Gevers *et al.* (1937), Ferguson and Wilson (1937), and Wagner (1917) have described rocks which seem to have been sediments altered thermally. Much nearer this deposit is the occurrence in the quartzitic sandstones and indurated grits of the metamorphic aureole of the Karroo sediments surrounding Salambidwe (Dixey *et al.*, 1955, p. 35). Hall also has described corundum in old rocks from Barberton and the point

arises whether aluminous mineral hydrates of such high content can survive sedimentation.

The author has described elsewhere high-alumina sediments from the Krrroo System in the Belfast (Transvaal) area; such rocks also occur in Ayrshire, Scotland. These sediments are possibly the result of leaching of rocks after deposition—that is, a bauxitic material which has not been transported as such—but there is evidence that such minerals can be transported (Griffith and Stuart) 1930 (9).

Table 1

	(1)	(2)	(3)
SiO_2	26·01	4·33	0·55
Al_2O_3	66·30	88·26	96·22
FeO	0·54	—	—
Fe_2O_3	0·41	2·75	0·77
TiO_2	5·55	0·20	—
MnO	0·01	Nil	—
CaO	—	0·49	0·27
MgO	—	0·76	0·2 (ca.)
Ignition loss	—	2·96	2·08
$+H_2O$	1·00	—	—
$-H_2O$	0·08	0·31	—
Na_2O	0·09	—	—
K_2O	—	—	—
	91·49	100·00	100·07

(1) Sillimanite-corundum rock from Namaqualand (Coetze, 1941).

(2) Corundum-bearing rock from near Salisbury. Analyst V. L. B. Note that alumina was determined by difference.

(3) Plumasite from Bandelierkop, Transvaal (Hall, 1920).

The minerals in the Namaqualand rock are corundum, sillimanite, and ilmenite and Coetze considers that the rock originated from the static metamorphism of dominantly aluminous sediments—a view contrary to that advanced by Cooper for the Tambane corundum-bearing rocks. The Salisbury rock is a very fine-grained intergrowth of corundum in a cherty texture. There is a pale-green mineral, soft and with one index greater than 1·56 and the other lower, this being a little low for a green chrome-bearing muscovite and the mineral is possibly talc. The fine-grained fibrous nature prevented better optical determination. Ilmenite occurs in both fine and coarse grains and the rock is completely unlike the Transvaal plumasites, which are very coarse-grained rocks with much calcic plagioclase and biotite. This rock is probably a sediment which has been thermally altered (statically as Coetze puts it) to a corundum-bearing rock, as described by Harker. It is noteworthy that in this

Fig. 3.—Radioactive Zone in Gneiss.

western area of Tambane there are occurrences of ilmenite-magnetite and, now recorded for the first time, magnetite-columbite. (The columbite was first determined by Garson and Bawden.)

Magnetite-ilmenite and magnetite-columbite float can be found all over the western foothills and flats of Ntondwe, but rarely *in situ*. The ilmenite is non-magnetic and has a brilliant lustre. Occasionally crystals have been found but more usually it occurs in irregular lumps about 8 cm. to 10 cm. maximum size. Near Chikoleka Village a large piece of columbite weighing over 140 lb. (at least 70 kg.) was found just near the surface.

Magnetite is a common heavy mineral in all the Tambane rocks and particularly in rocks above and below the Sigulane pegmatite. Practically all the allanite contains small amounts of magnetite. In Table 2 two analyses of columbite and magnetite are given. A microscopic examination shows that the mixture of magnetite and columbite is purely mechanical and Bawden has showed the author that many large lumps of magnetite if broken up with a hammer into lumps of 2 cm. to 3 cm. cube show a separation of magnetite and ilmenite or columbite, by a vein of quartz in this instance. The magnetite is uniform in texture and isotropic but the

non-magnetic under crossed nicols shows an irregular mosaic of the same mineral reminiscent of the texture of a quartzite but much less equigranular. Adjoining the quartz vein the crystal grains are at least five times as large and the contact is irregular but sharp. Occasionally in the columbite some quartz can be seen. The magnetite and the columbite phases are not always separated by vein quartz; an intimate contact can be seen, sharp but inter-penetrating; the columbite appears to be later than the magnetite. The magnetite seems to contain small amounts of columbite and niobium oxide always seems to predominate over tantalum oxide.

Columbite and tantalite have not been investigated in polished section extensively and Short (1940), for example, does not mention them at all. Edwards (1954) noted that columbite-tantalite form a stable continuous sold-solution series and so do tantalite and cassiterite. In an earlier work Edwards described the tantalum-niobium minerals from Western Australia (1940) and the relationships between titanium and antimony are of interest here for comparison with the nearby Tete (Mavudze Deposits) described by Davidson and Bannister (1950) and de Luna and Freitas (1953). At Tete stibno-tantalite

Fig. 4.—Nodules of Betafite Enrichment in Gneiss.

Table 2

	(1)	(2)
SiO_2	0·36	—
Al_2O_3	Nil	—
FeO	16·40	—
Fe_2O_3	75·80	—
TiO_2	5·15	20·85
CaO	0·07	—
NgO	0·03	—
Nb_2O_5	1·13	33·63
Ta_2O_5	0·60	5·75
U_3O_8	Nil	4·3
	99·46	

(1) Magnetite from Tambane, west side. Analyst V. L. B.

(2) Radioactive ore from Chikoleka. The uranium oxide content was determined radiometrically. Analysis by Gold Fields Laboratories, Johannesburg.

occurs as well as the titanium-rich minerals, including davidite, which are discussed later.

The columbite from Chikoleka (called T.16/1) and the Eastern Range (on true north bearing of 165° and $6\frac{1}{4}$ km.) are non-radioactive but that from Chikoleka, just to the west of Tambane Peak, is intimately associated with opaque radioactive minerals, including uraninite and pitchblende. The Chikoleka columbite in polished section is very similar to that from near the Rest Camp (Float) but has a much more oriented texture and there are more silicate minerals present. The S.4.E. columbite shows very marked columnar structure with the silicate minerals oriented as well.

Bowie and Taylor have included columbite and tantalite in their system of ore mineral identification. In Table 3 some partial analyses are given of black minerals apparently opaque in hand specimens. An analysis is also given of a black tourmaline (schorlite) which was brought in by one of the Africans and shows clearly the difficulty of identifying and distinguishing these minerals in hand specimens by megascopic methods. The great variation in composition is noteworthy, a point also made by Palache *et al.*, p. 784, who state that marked variation in the ratio of Cb to Ta and in Fe to Mn is often found in material from the same locality and even in a single specimen or crystal. Strongly magnetic here means that a lump of the specimen can support itself on a high-intensity permanent magnet. A specimen from Schott's trench consisting of "pebbles" after some breaking down into small nodules gave the following separation (% by weight): Strongly magnetic, 55; weakly magnetic, 1,

Table 3

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
$Nb_2O_5 + Ta_2O_5$	50·6	60·5	41·1	55·0	71·6	40 *ca*	0·8
FeO	41·6	17·8	5·24	37·6	5·7	40·7	40·2
TiO_2	0·6	15·9	not det.	2·9	0·1	20·9	0·5
MnO	0·03	—	not det.	1·8	0·1	1·2	2·9
CaO	—	—	2·22	—	—	—	—
MgO	—	—	0·70	—	—	—	—
SiO_2	—	—	0·28	—	—	—	—
SnO_2	—	—	1·51	—	—	—	—
Insolubles	—	—	—	—	—	—	—
	92·83	94·2		96·3	78·0	102·8	102·4
Translucence and colour			Opaque	Opaque		Reddish brown	
Magnetism—hand specimen			Nil	Nil		Nil	
powder			Partly some very magn.	Partly		Nil	

(1) Black heavy non-magnetic mineral from Joseph Village, Tambane West, found by G. D. Garlick.

(2) Black opaque mineral from the Little Ngona River Betafite-zircon mineralization.

(3) Partial analysis of columbite from the Rest Camp. The manganese in this is reported to be high in another specimen from the same place, over 10% MnO. High manganese columbite is according to Palache *et al.*, p. 782, translucent; the higher the manganese content the more light is transmitted.

(4) Black lustrous mineral found by C. P. J. Nagel, Ntondwe Pass.

(5) Columbite from Schott's Trench near Beacon No. 38, Tambane Peak.

(6) Black opaque mineral from Trench near Beacons 38 A to 38 B, Schott trenches.

(7) Black opaque mineral from Monso Village, Tambane East, schorlite plus some iron oxide.

All analyses by V.L.B.

and non-magnetic 44. The non-magnetic material had the following partial composition: Nb_2O_5, 60·5%; TiO_2, 19·3%, and MnO, 1·2% (Analyst, V.L.B.).

The determination of specific gravity is not very useful except when it is found to be very high for tantalite. The specific gravity varies from 5·20 for columbite to 7·95 for tantalite. A black opaque mineral non-magnetic from west of the Rest House, Tambane, was found to contain: $Nb_2O_5 + Ta_2O_5$, 3·5%; FeO, 2·6%; TiO_2, 0·2%; MnO, 4·9%, and insolubles, 49·7%. The large proportion undetermined makes identification difficult but it is evident from Table 3, analysis 6, that columbite is mixed with schorlite and magnetite. Behier in his work on the minerals of Mozambique does not show any niobium-tantalum in his analyses of tourmaline but stibno-tantalite is described and columbite. It is possible that the rare earths account for some of the missing elements in the analyses given as so much allanite has been found in the same occurrences.

Another heavy very dark non-magnetic mineral found in the Western Tambane and Eastern Tambane ranges is a garnet. One from Laak's camp south of the Little Ngona River deposit, consisting of a large irregular mass, had the following composition: SiO_2, 32·50%; Al_2O_3, 26·70%; Fe_2O_3, 35·50%; MnO, 5·60%, and TiO_2, 0·03% (analysis by the author).

It is evident that only magnetite is readily

Fig. 5.—Davidite with Halo in Gneiss.

and positively distinguished in hand specimens and that ilmenite, columbite, and mixtures of these minerals with one another are not readily distinguished. Garnets and schorlites require careful examination and even these may contain columbite in minor amounts. Allanite has been shown to contain magnetite and is closely associated with columbite. It is heavy and in the hand specimen can be confused with columbite. Schorlite and allanite can readily be detected in the powder examination under the microscope as both are translucent to transparent and strongly pleochroic. The high-manganese columbite from the Eastern Range and the Rest House, first identified by M. S. Garson, is reddish brown and translucent but these are the only specimens so far reported, so that the quickest method is to separate the non-magnetic material, determine whether it is opaque or not under the microscope, and then determine niobium and tantalum. So far niobium in this area always exceeds tantalum.

Molybdenite.—G. D. Garlick has found molybdenite closely associated with uraninite, columbite, and pyrite at Chikoleka. The molybdenite is often in completely non-radioactive ore in grey to brown feldspathic gneisses as films along the schistosity but also in small nodules of 1 cm. or so. Although not identified in the same specimens molybdenite is very closely associated with columbite, monazite, zircon (cyrtolite), pyrite, uraninite, and rutile (identified microscopically by Dr. A. P. Millman) in feldspathic gneisses, so that the temperature relationships are a mixture of low temperatures (uraninite and pitchblende) and very high temperatures, zircon and molybdenite.

One other non-radioactive mineral is worthy of note for its significance in the genesis of these ores and that is lazulite. Lazulite occurs in the nepheline syenite of the Eastern Range, the Little Ngona River, and also along the western side of Ntondwe. Cooper reported it as sodalite, although pyrite has not been noted jointly with the sodalite (lazulite). The author agrees with Harker that it is a metamorphic mineral formed from sulphides and hence an indication of intense metamorphism. Arsenopyrite was reported by Miller in the Supe River near Tambane Market and in the same area at Malico Village pyrite occurs in thin veins in allanite.

Host Rocks

The radioactive and non-radioactive minerals of Tambane and the Mwanza Fault have been found in a wide variety of rocks but none of them very basic. This is in marked contrast to the Tete davidite, which occurs in anorthosites (a scapolitized fault zone) in a gabbro complex. According to Nininger (1954) this is rare but occurs in the Lake Athabaska area as well. It can be noted that Bridges has also reported allanite in the basic rocks of Tanganyika. Betafite, columbite, zircon, and allanite have been found in the Tambane West area in feldspathic gneisses, sometimes partly nephelinized. Allanite, monazite, and davidite have been found in rocks in epidote in the Tambane Market area and uraninite, columbite, allanite, and molybdenite have been found in feldspathic gneisses just to the west of Tambane Peak. In or near the Sigulane Pegmatite on Tambane west have been found allanite, davidite, betafite (only near the pegmatite), monazite, and magnetite.

Only three radioactive pegmatites and the aplite near Miller's sulphide zone have so far been found in the whole area between the Shire River and the Portuguese Boundary, the Mwanza Blantyre Road on the north and the Mwanza Fault to the south. The Tambane aplites near the Little Ngono River are all non-radioactive and very low in heavy minerals. On the other hand, at the Wakrumadze–Shire Rivers confluence there are some slightly radioactive aplites.

The Sigulane pegmatite to the west of Tambane is radioactive ; then about a mile to the east of this there is a non-radioactive quartz-schorlite pegmatite and about ½ mile to the west of this again there is an allanite-schorlite pegmatite that is radioactive. About 4 miles due east of Chikwawa, just near the Mtumba Fault, there is a slightly radioactive pegmatite containing some monazite. Over the whole area pegmatite containing hornblende, muscovite, and in one case some lepidolite, all have a very low radioactivity in the field. The Mwanza River davidite (M.48) is associated in the field with a pegmatite but the main part of the pegmatite is non-radioactive and only on its margins does it occasionally contain some davidite. In the case of the Sigulane pegmatite the radioactive minerals in every case are concentrated along joints, usually in the joints normal to the strike of the pegmatite and hence they are very much later than the pegmatite itself.

Cooper has described corundum-bearing pegmatites and just east of Tambane Peak between two lines of radioactive mineralization are corundum-bearing rocks, many of them coarse-grained quartz-feldspar rocks but without much mica—that is, pegmatites which are non-radioactive.

It is interesting to note what Fersman has to say on the subject of the alumina-rich pegmatites. In 1930 he wrote: "The question of aluminium enrichment in granitic pegmatites poses an important problem, as important from the theoretical point of view as the practical." He goes on: "Corundum with dumortierite can be seen in Colorado where the pegmatite traverses gneiss; here, as in the preceding case, the concentration of corundum is in relationship to the inclusion of gneiss."

Large crystals of corundum have been found in the Tambane area up to 5 lb. or 6 lb. in weight but the simple conclusion, that large crystals equals pegmatitic conditions, means intrusion is not justified. Such crystallization can take place by processes of metamorphism just as readily. The detailed trenching and winzing has shown that the corundum is not in the same ore-body as the uraninite, betafite, zircons, and columbite, for example, but in parallel and closely associated zones, in the case of Chikoleka, near Tambane Peak, with the total absence of pegmatites. The Sigulane pegmatite does not contain corundum and in fact none of the pegmatites do. Most of the pegmatites are simple quartz-feldspar rocks with little or no muscovite and no large books of mica have been found. The micas are rare in the pegmatites yet between the Rest Camp and the Little Ngona River deposits there are wide bands of pure biotite rocks (biotitites) which do not contain any other minerals at all. The field work strongly suggests that all these rocks are of metamorphic origin and the mineral deposits as well.

Corundum can be formed readily from aluminous sediments and the fact that some of it is blue in colour suggests such an origin. The fact is that none of the alumina-silica minerals, such as andalusite, sillimanite, and kyanite, have been found.

The solvsbergite dykes are usually noticeably radioactive, often giving in the field as much as three to five times the background count in the adjoining rocks. The percentage of heavy minerals in one such specimen was found to be 0·26% by weight. The radioactivity was determined by C. F. M. Bawden as 0·25 lb. per ton and assuming 7% U_3O_8 in davidite, the amount found in the Mwanza davidite, this would give 0·39 lb. per ton in the radioactive solvsbergite. The solvsbergite therefore seems to contain davidite. The heavy minerals are black and opaque and are magnetic.

The radioactive and non-radioactive minerals occur in three ways in Tambane and the Mwanza Fault, as follows:—

(1) In bedded deposits conformable with the gneissosity or schistosity in gneisses and schists or granulites.

(2) In irregular and nodular masses in the gneisses.

(3) In the joints and along the walls of the Sigulane pegmatite (Figs. 3, 4, and 5).

The Little Ngona River, the Chikoleka, and other deposits are all bedded deposits dipping about 30° to 40° to the west. They are well defined in the gneissosity and the gneisses are in general of sedimentary origin. The Mwanza Fault davadite-brannerite deposit is in a granulite dipping rather steeply to the south-west and not far from a very large rift valley type fault, the Mwanza Fault. Photographs show these quite clearly. Even the large masses of uraninite found near Chikoleka are from bedded deposits and not pegmatites and the same applies to the well-defined crystals of zircon. It is noteworthy that in the case of the zircons that the pyramid is dominant and not the prism, which is usually not well defined at all. The subordinate part played by sulphides also suggests that hydrothermal activity played little part in the development of these minerals.

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Instrumentation and Process Control

Notes on control processes at two plants in the United States

A. Hegarty

(1) Borax Refining

Engineers responsible for the design of the huge new United States Borax and Chemical Corporation borax-processing facility at Boron, California, were faced with the problem of automating, as far as possible, the extensive level measurement, indication, and control requirements of the plant. The handling of large volumes of highly-abrasive raw borax ore, *plus* large quantities of in-process slurries and solutions were involved. Difficult environmental conditions resulted from huge quantities of heavy, constantly-shifting, abrasive ores, and attendant crystallization.

These conditions made it impracticable to use most of the available level-indicating and control equipment—such as, direct-contact diaphragm devices, differential instruments, and " bubble tube " devices. After a thorough evaluation of existing methods, plant design engineers chose " Level-Tek " and " Level-Tel " capacitance-type systems designed by the Robertshaw-Fulton Controls Company, of Anaheim, California, to handle important level measurement, monitoring, and control functions in major plant areas.

Incoming ore in chunks which is processed in both saturated and supersaturated form. The incoming ore storage tanks are approximately 150–200 ft. high and 50 ft. in diameter.

The Level-Tek units are used in pairs on the storage tanks of raw borax ore, operating as high-low fixed-level monitors. Separate probes are installed horizontally in tank sides at the critical high and low levels. Variations in level, either above or below the probes, result in a control sequence which either stops or starts the raw-borax input flow, to ensure that adequate supplies of borax ore are available for processing at all times.

The Level-Tel systems provide continuous monitoring and control of levels in the processing tanks of " borax liquor." Processing tanks include slurry and solution tanks, measuring from 20 ft. to 30 ft. in height and diameter. Flexible capacitance probes are mounted in 4 in. to 6 in. diameter stilling

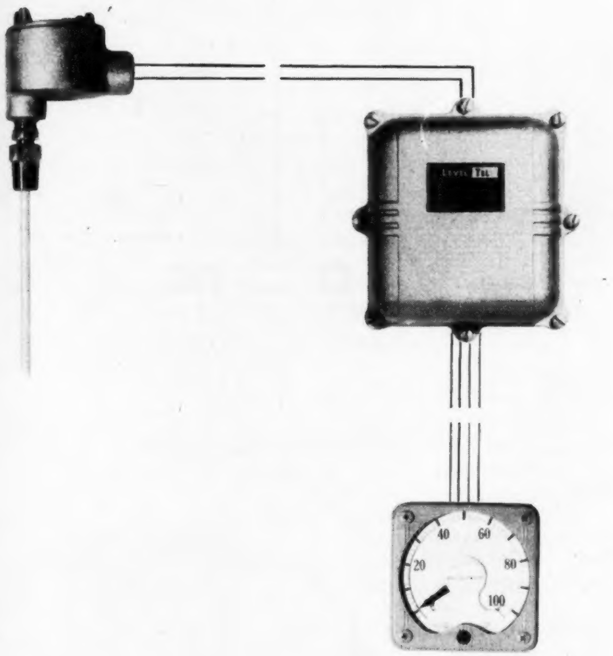


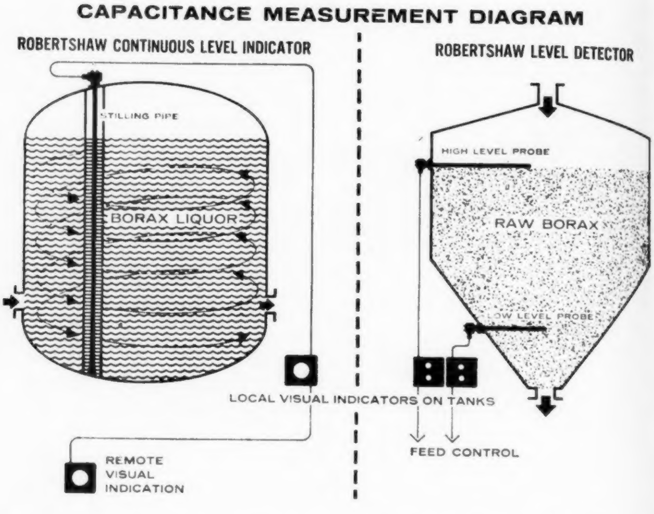
Fig. 1.—Indicator System.

pipes, installed vertically from the top of the tanks to guard against agitation. As the liquor level drops below the preset point, Level-Tel signals the condition to the indicator unit. The signal is then converted to air pressure to control valves which admit raw product to the tank. Periodic zero-point checking and calibration procedures are readily accomplished, using standard instrumentation. Probe inspection and cleaning is simplified as the flexible Teflon-covered probes are easily removed from the stilling pipes.

A further feature of the installation is the employment of Level-Tek units as high-low level indicators on the processing tanks, in addition to the primary Level-Tel systems. These units are mounted externally and act as safety monitoring elements in the event of failure in the continuous-level measurement and control systems. Continuous visual readings of monitored levels, as they exist at the various process installations, are available on indicator units located in remote-control centres as well as at the tanks themselves.

The level instrumentation systems operate on the simple well-proved principle of a capacitance bridge. Located in the measurement units, the capacitance bridge is unbalanced by an increase or decrease in probe capacitance, caused by the changing dielectric constants as material levels vary within the tanks. The Level-Tek systems operate as fixed-level " on-off " type controls, desired level points being determined by arbitrary high and low positions selected for the various tanks. Employing vertical Teflon insulated probes installed through the top of the process tanks the Level-Tel systems, as utilized in this installation,

Fig. 2.—



provide continuous-level indication and control, with control action set at predetermined points to provide the necessary flow-valve openings and closures.

(2) Uranium Plant

At the Homestake-Sapin Partners uranium oxide recovery mill near Grants, New Mexico, level instrumentation and process controls are utilized to a degree seldom achieved in the mining industry. Because of the remote location of the plant and special economic considerations, engineers were requested to design for maximum automation and a

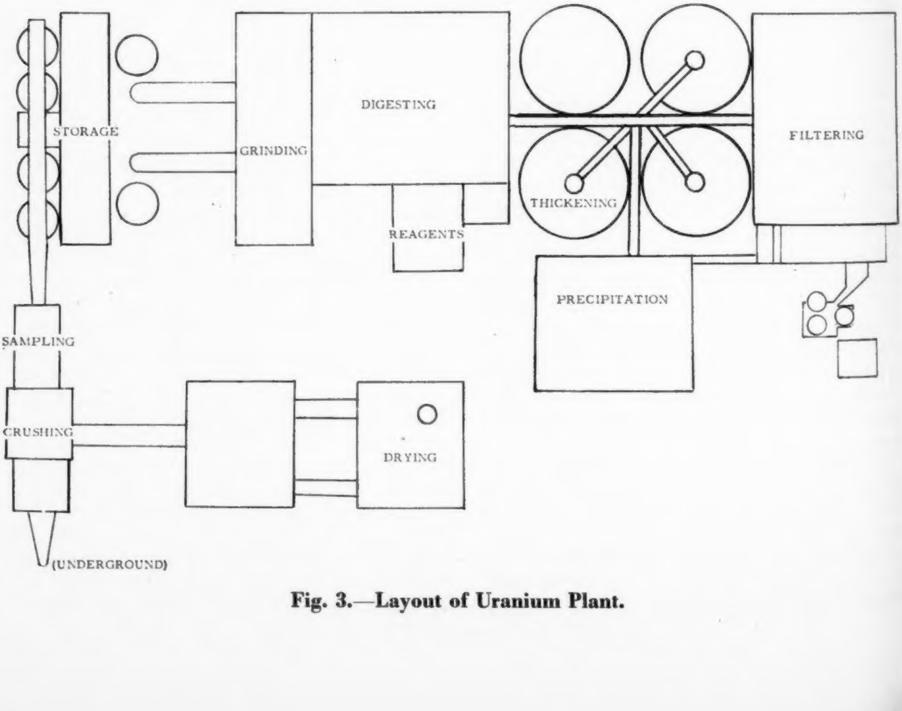


Fig. 3.—Layout of Uranium Plant.

minimum operating staff. These requirements necessitated the utilization of advanced engineering concepts, since the complex mill processes and recovery techniques for uranium oxide (yellow cake) from ores were in themselves a relatively new mining problem.

There are two available methods for dissolving essential uranium products—namely, the sodium carbonate-sodium bicarbonate leach method and the sulphuric acid leach method. Many processing complexities peculiar to uranium recovery operations are encountered in the practical implementation of these methods. Thus, the more conventional approaches to mine-ore process control could not serve as a convenient model to answer the design requirements at Homestake-Sapin.

Fig. 4.—Probe-Type Capacitance Unit.

In addition to the need for accurate indications it was evident that any level-measurement equipment contacting ore process solutions and slurries comprising large amounts of ground-up sand-stone (raw uranium ores contain approximately 85% silicon oxide) would have to be unusually sturdy.

To meet these highly restrictive problems plant design engineers chose "Level-Tek" probe type capacitance systems and control units were again chosen for installation at 64 critical locations throughout the plant. The installations include both local and remote readout facilities.

Level-Tek equipment is incorporated to fulfil virtually every type of level indication and control requirement throughout the plant. To gain an idea of the unusual variety of level applications involved in the ore process trail it is necessary to outline the major operating steps at Homestake-Sapin. Designed to handle 1,500 tons per day of uranium sandstone ores the plant is divided into nine major processing areas, *plus* a waste disposal area. Operational subdivisions include : (1) Crushing, (2) sampling, (3) grinding and classification, (4) thickening and digestion, (5) thickening and filtering, (6) steam generation and recarbonation, (7) precipitation, drying, and packaging, (8) reagents preparation, (9) power generation.

A typical example of the exacting and divergent utilization of these capacitance-level systems is found in the operation of the "digesters." In the thickening and digestion area eight pulp-digester vessels per circuit are integrated into a unified process-stream sequence. These tanks are installed with a 6-in. step-down between each succeeding tank. This step-down is adequate for pressure drop between vessels. The final digester in each circuit is discharged to the pulp-to-pulp heat exchanger.

The pulp level in the final digester controls the discharge rate. This is accomplished through the use of three Level-Tek capacitance probes per circuit, each set for a different level. As the level rises in the final digester, first one, then two, and finally three feed valves to the pulp-to-pulp exchanger are opened. In addition to the three control probes there is an additional Robertshaw probe set at a pulp level 6 in. higher than the previous high control probe. This fourth probe acts as a warning to the operator in case of stuck valves.

System pressure is adequate to move the hot pulp through the exchanger at a flow rate commensurate with the rate of use in level within the digester. "Balanced" operation of the entire flow sequence in each of these step-wise circuits is heavily dependent upon the accuracy of Robertshaw capacitance probe instrumentation.

Variable-Speed A.C. Motors

J. L. Watts, A.M.I.E.E.

The author reviews the design and control system of special Motors

Induction Motors

Most a.c. motors used in industry are induction motors. The primary windings of these motors are fitted in slots in the stator core and induce current in the secondary conductors, which are fitted in slots in the rotor core. The currents passed through the distributed stator windings of a polyphase induction motor create a magnetic flux Φ which revolves round the stator core and windings at synchronous speed N_s r.p.s. The synchronous speed may be regarded as the theoretical no-load speed of the motor and is equal to $\frac{f}{p}$, where f is the frequency of the supply (cycles per sec.) and p is the number of pairs of poles for which the motor is wound.

The revolving flux induces e.m.f. (voltage) E_r and current I_r in the rotor conductors, which reacts with the revolving flux to create the motor torque T. Provided the motor is loaded within its capacity it will run automatically at the speed at which it develops a torque equal to the resistance torque of the load to which it is coupled. The torque is proportional to the revolving flux Φ, the rotor current I_r and the power factor F of the rotor circuit. I_r is equal to $\frac{E_r}{Z}$, where Z (ohms) is the impedance of the rotor circuit. E_r is proportional to Φ and to the frequency f_r of the induced rotor current. f_r is equal to $f \times S$, where f is the supply frequency and S the fractional slip, equal to $1 - \frac{N}{N_s}$, N_s being the synchronous speed and N (r.p.s.) the speed at which the motor runs.

Torque and Speed

The power factor F of the rotor circuit is equal to $\frac{R}{Z}$, where R (ohms) is the resistance of the rotor circuit. It follows that the torque T is proportional to

$$\Phi\left(\frac{\Phi \times f \times S}{Z}\right) \times \frac{R}{Z},$$

and is equal to

$$\frac{k \times \Phi^2 \times f \times S \times R}{Z^2},$$

where k is a constant for the motor. It will be seen that the fraction of the synchronous speed $\frac{N}{N_s}$ at which the motor runs is equal to

$$1 - \frac{T \times Z^2}{k \times \Phi^2 \times f \times R}.$$

The impedance Z (ohms) of the rotor circuit is equal to $\sqrt{R^2 + X^2}$, where X is the inductive reactance (ohms) of the rotor circuit. The ratio $\frac{N}{N_s}$ is thus equal to

$$1 - \frac{T\,(R^2 + X^2)}{k \times \Phi^2 \times f \times R} \quad . \quad . \quad (1)$$

Squirrel-Cage Induction Motors

On a supply of constant voltage and frequency f the revolving magnetic flux Φ is practically constant, while the resistance R of a squirrel-cage motor has a constant value. The speed of a squirrel-cage induction motor automatically falls on increased load, but normally falls by no more than about 3% to 7% of the synchronous speed from no load to full load, the fall of speed largely depending on the resistance R of the rotor. The squirrel-cage motor thus falls in the category of a constant-speed machine. On a 50-cycle supply the synchronous speed of an induction motor may be 3,000, 1,500, 1,000, 750, 600, 500, or 375 r.p.m. and so on, depending on the number of poles for which it is wound.

It is possible to obtain a squirrel-cage motor which is designed to run at one of two or more speeds by winding the stator with two separate windings, or with a tapped stator winding. The motor is used in conjunction with a special switch, by means of which the number of stator poles can be changed. However, on each setting of the

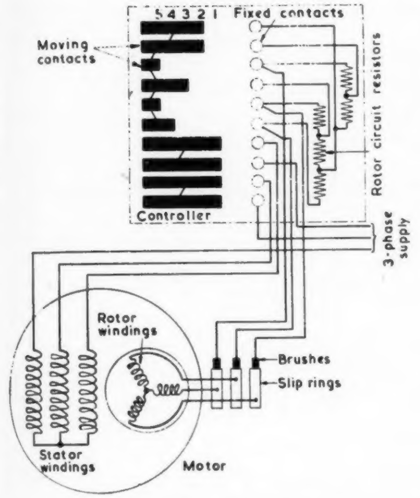


Fig. 1.—Connexions of a Slip-Ring Motor and Speed Controller.

switch, the motor speed varies by a few per cent. only from no load to full load, depending on the synchronous speed selected.

Speed Control.—The rotor of a slip-ring induction motor is wound with insulated conductors which are connected to slip rings on which ride brushes connected to an external starting resistor, as in Fig. 1. The normal rotor starter is only intended to be used during starting, the motor being run with the rotor windings short circuited either at the rotor starter or at the slip rings. When the rotor windings are thus short circuited the motor runs at practically its synchronous speed on no load, and a few per cent. less on full load, as in the case of a squirrel-cage motor.

It is, however, possible to run a slip-ring induction motor at reduced speed by connecting external resistance in its rotor circuit, using a controller as in Fig. 1. The reactance X of the rotor circuit of an induction motor when running is usually quite low, but increases on reduced speed almost in proportion to the fractional slip S. The motor develops its maximum torque at the speed at which X is equal to R. Under stable conditions the motor runs at a higher speed than that at which it develops maximum torque and R then exceeds X. Formula (1) shows that an increase of rotor circuit resistance R will reduce the speed of the motor on a given load torque T.

Fig. 2 shows the speed-torque curves for a particular slip-ring induction motor when run, with various values of rotor-circuit resistance, from a supply of constant voltage and frequency f. The reactance X of the rotor is practically proportional to the fractional slip S and has its maximum value Y (ohms) when switched on at zero speed. If the rotor windings themselves have a resistance R equal to $0{\cdot}1\ Y$ the motor may run at about 97% of synchronous speed on full load, as indicated in curve A. If external resistance equal to $0{\cdot}4\ Y$ is connected in the rotor circuit, so that the total rotor resistance $R_2 = 0{\cdot}5\ Y$, the motor may run at 92% of synchronous speed on full load, as in curve C. Curves B, D, E, and F show the effect of other values of rotor-circuit resistance. In the case of a load requiring a reduced driving torque at reduced speeds, as indicated by the curve G, a greater increase of rotor-circuit resistance is required for a given reduction of speed than in the case of a constant-torque load.

When it is required to run a slip-ring motor at reduced speed the rotor starter is replaced by a speed regulator having substantial resistors which are capable of carrying the rotor current for the required

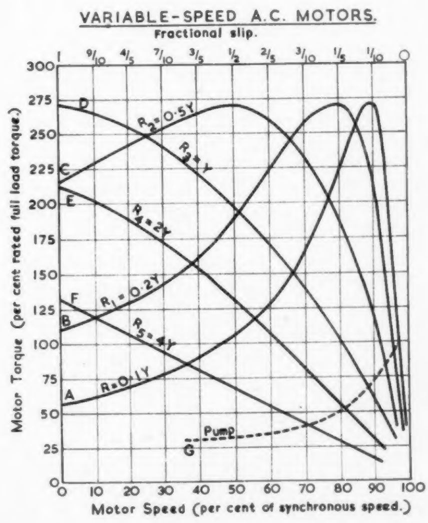


Fig. 2.—Speed Torque Curves for a Slip-Ring Motor.

VARIABLE - SPEED A.C. MOTORS

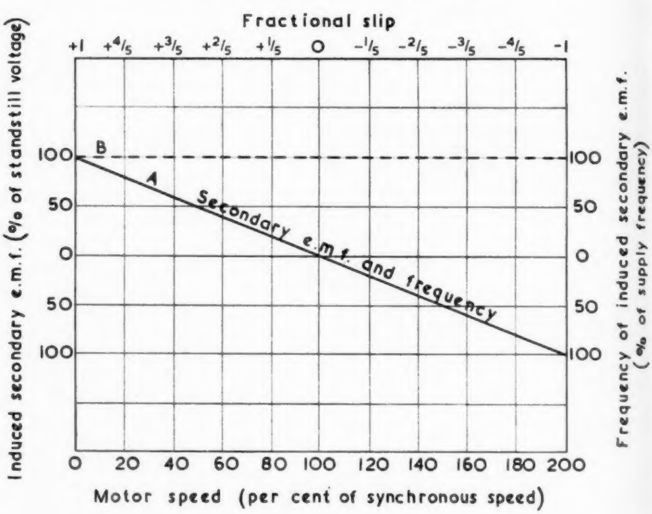


Fig. 3.—Frequency and Induced E.M.F. in Secondary Circuit of an A.C. Motor.

running period without overheating. This method of speed control cannot be used to run a motor above its synchronous speed. One disadvantage of speed control by rotor-circuit resistance is that it results in the motor speed varying considerably on changed load, the control having little effect on the no-load speed. For example, reference to Fig. 2 shows that, if the motor is run with rotor-circuit resistance $R_4 = 2Y$ (curve E), the speed will automatically rise from 63% to 83% of synchronous speed when the load falls from the rated full-load torque to 50% of full-load torque.

Economics of Speed Control.—A considerable disadvantage of speed reduction by this method is that the fall of speed is obtained at the expense of waste of power, which is converted into heat in the speed-control resistors. On a constant-load torque the power P_r delivered to the rotor by the revolving magnetic field, and the power input P_e to the motor, are practically constant. Two examples will illustrate the effects.

Taking first the case of a load which requires a constant torque at all speeds, equal to the rated full-load torque of the motor. It will be assumed that the efficiency of the motor on full load at its normal speed, of 97% of synchronous speed, is 88%, the rated horse power being H h.p. The electrical input P_e to the motor under these conditions will be equal to

$$\frac{\text{Output}}{\text{Efficiency}} = \frac{H}{0{\cdot}88} = 1{\cdot}14\,H.$$

It is required to reduce the speed to 82% of synchronous speed by increasing the rotor-circuit resistance from R to R_3 (curve D). The power input to the motor ($1{\cdot}14\,H$) will be practically unchanged, but the mechanical power output (proportional to torque × speed) will be reduced to

$$\frac{82}{97} \times H = 0{\cdot}85\,H.$$

Thus the overall efficiency will be reduced from 88% to

$$\frac{0{\cdot}85\,H}{1{\cdot}14\,H} \times 100 = 74{\cdot}5\%.$$

The losses in the rotor-circuit resistors at the reduced speed will be proportional to the speed reduction and equal to $0{\cdot}15\,H$.

On the other hand, if the motor drives a pump having the characteristic shown in curve G, requiring the full-load torque and horse power of the motor to drive it at 97% of synchronous speed, it may be necessary to increase the total rotor-circuit resistance from R to R_4 ohms (equal to $2Y$) to reduce the speed to 82% of synchronous speed, as will be noted from curve G. Due to the pump requiring only 55% of the full-load torque of the motor at 82% of synchronous speed the

mechanical output of the motor at that speed will be equal to

$$\frac{55}{100} \times \frac{82}{97} \times H = 0{\cdot}465\,H.$$

The electrical input to the motor circuit at 55% torque will be proportional to the torque and inversely proportional to the normal efficiency of the motor itself at that torque, which may be approximately 86%. Thus the input at 82% of synchronous speed would then be equal to

$$\frac{0{\cdot}55\,H}{0{\cdot}86} = 0{\cdot}64\,H.$$

At the reduced speed the overall efficiency of the whole motor circuit would be equal to

$$\frac{\text{Output}}{\text{Input}} \times 100 = \frac{0{\cdot}465\,H}{0{\cdot}64\,H} \times 100 \doteq 73\%.$$

The losses in the external rotor-circuit resistors at the reduced speed, proportional to the speed reduction $\times$ torque, would be equal to

$$\frac{97-82}{97} \times 0{\cdot}55 \times H = 0{\cdot}085\,H.$$

The overall efficiency in each case is roughly proportional to the speed, but the losses in the speed-control resistors are also approximately proportional to the torque. Whilst this method of speed reduction is seldom employed to drive a constant-torque load at reduced speed for long periods, it may sometimes be used with a drive requiring reduced torque at reduced speed. The full-load torque the motor can develop without overheating is practically constant; thus the full-load horse power is reduced in proportion to the speed.

To reduce the speed some of the e.m.f. E_r, induced in the rotor by the revolving flux, is absorbed in the external resistors. The approximate value of the resistance R_s (ohms) required in each phase of a star-connected speed-reducing resistor to reduce the speed of the motor by $N\%$ can be roughly calculated by the formula

$$R_s = \frac{N \times E}{1{\cdot}732 \times I}.$$

In this formula I (amps) is the rotor current and E is the open-circuit rotor voltage. If the latter is not marked on the motor it can be measured by connecting a voltmeter between any pairs of slip rings, with the brushes raised from the slip rings and the stator switch closed with the rotor at rest.

The mechanism of speed control by rotor-circuit resistance is as follows:—An increase of the resistance immediately reduces the rotor current I_r and the motor torque. Since the latter is then less than that required to drive the load the motor starts to decelerate. As the speed falls, and the slip $S\left(1-\frac{N}{N_s}\right)$ increases, the frequency f_r of the induced rotor (secondary) e.m.f. E_r, and the value of this e.m.f., increase as in Fig. 3. The reactance X of the rotor increases due to this increased frequency, so that the induced rotor current I_r increases at a lower rate than E_r and the rotor power factor F falls due to the increase of X. The increase of I_r raises the motor torque as the speed falls, deceleration ceasing when the motor torque has again risen to a value equal to the resistance torque of the load, whether this is constant or has fallen at the reduced speed. A very similar effect occurs if the load on the motor is increased.

Voltage Injection.—The reduced rotor current required to cause the change of speed can be accomplished by injecting another voltage into the rotor circuit, instead of absorbing some of the induced rotor e.m.f. E_r in resistors. This is the basis of many types of variable-speed a.c. motors, which also operate as induction machines. It is, however, necessary that any injected voltage shall have the same frequency f_r (equal to Sf) as the induced rotor e.m.f. E_r. Thus the injected voltage must be of a frequency which automatically varies with the motor speed and must have a frequency which is proportional to the fractional slip S. This introduces certain complications and necessitates the use of some form of frequency converter, such as a commutator and brushes as used in many variable-speed a.c. motors.

Stator-Fed Commutator Motor

One variable-speed polyphase a.c. motor has its primary windings fitted in the stator slots, as in an ordinary induction motor, tappings being brought out from the stator windings. A d.c. type of winding is fitted in the rotor (secondary) slots and connected to a commutator, on which ride brushes which are connected to the tappings on the stator windings through a selector switch.

In addition to their normal function of producing the revolving magnetic flux the stator windings, therefore, also act as an auto-transformer and apply voltage of supply frequency to the commutator brushes, of a

value depending on the setting of the selector switch. The rotor and commutator revolve at *N* r.p.s. and convert the injected voltage of supply frequency at the brushes to the same (slip) frequency as that of the induced rotor current, whatever the motor speed. Such motors are built in small sizes up to 10 h.p. or so and may have about 10 sets of stator tappings to run the motor at one of about 10 speeds to give a maximum speed about 3·5 times the minimum speed. Since the injected voltage is independent of the motor load there is little variation of motor speed on varying load and the external losses are nil.

(To be concluded)

Ore-Dressing Notes

(5) *Roasting.*

Principles of Fluidized Treatment

In 1959 the publication of "The Periodic Review of the Metallgesellschaft," suspended in 1939, was resumed. Among the contents of its first post-war issue is a valuable review of fluidized roasting practice by Dr. Franz Schytil, in which practice is mathematically related to the governing principles. The fluidized solids technique was first used on an important scale in the Winkler gas generator. This worked on lignite or its low-temperature coke to produce water gas, leaving a residue sufficiently rich to serve as boiler fuel. Attempts to gasify other types of coal were then unsuccessful although catalytic cracking came in during the war. Post-war research has extended the field of application considerably and to-day some 60,000 tons of sulphide minerals are roasted daily, of which 40,000 tons are pyrite.

Once started sulphide roasting is exothermic, the driving force being oxidation to SO_2 with, at lower temperatures, some SO_3. Control is concerned to prepare the metal in the residue for further treatment and to avoid undue dilution of the sulphur-bearing exit gases. From one of the oldest devices, the multiple-hearth roaster, was developed the flash roaster in which finely-ground dry concentrates are blown downward into heated rising air. Fluidized-bed roasting breaks new ground, since the feed is introduced into hot and already partly roasted solids teetering in a rising column of air. When this rising air balances the weight of the bed there is generalized instability. If the air current is increased beyond this expansion, mixing, and agitation increase, as in elutriation. The interplay between the size and density of the particle, the size range, the velocity, and reaction characteristics of the gas can be brought into control by the choice of a suitable shape of container and by regulation of reaction rate, temperature, and gas velocity. The first important factor is the ratio between v (velocity) squared and the product of gravitational acceleration, the Froude number $\frac{v^2}{dg}$, where d is the particle diameter. This is combined with the Reynolds number Re and the void fraction to give an equation of state at commencement of fluidization and is developed by the author in a series of equations which define the upper limit of the process, modified in practice by the effect of the smallest particles on the generalized behaviour of the bed.

After a description of the Winkler roaster, which Schytil treats as a prototype, discussion turns to the two Dorr systems, the BASF and the INCO. Cooling control in a fluidized roaster is achieved in various ways. Water may be directly injected ; the solid-liquid ratio of the newly-entering pulp may be varied ; waste-heat boiler elements can be built into the fluidized bed ; cold roasting gas can be partly de-oxygenated and recycled, or cold recycled material from previous roasting can be added. In the Dorr FluoSolids plant, used typically for flotation slurries, where the particle size is below 150 mesh, low gas velocities are used. The author describes its use in roasting a pyrrhotite by-product from copper flotation, the feed containing 35·7% sulphur with from 8% to 10% moisture. Exit gases finally become calcium bisulphite liquor for a cellulose factory. The charge is slurried in at 70% solids by means of a diaphragm pump through several pipes 18 cm. above the fluidized bed. Extra water is injected to maintain a temperature of 900° C. ; roasting air is blown in at 300 cu. m. per sq. m. N.T.P. and the unexpanded bed of roasted magnetite would be about 1 m. deep, the

charge being roughly balanced stoichiometrically with available oxygen. With an internal diameter of 4·85 m. the roaster has a duty of 80 tons per day dry feed. Exit gas contains 13 volumes % SO_2, 1·2% SO_3, and 1% oxygen. The original charge is reduced to 79%, of which 45% leaves by an overflow 1·5 m. above the supporting grid, the remainder going out as fly ash. Residual sulphur is about 0·5% and 94% of it is recovered as a purified roasting gas. Pressure drop is about 1,400 mm. water column, of which 500 mm. is lost in the nozzle plate. There is slight agglomeration during roasting and most of the *minus* 200 mesh material reports as fly ash, fully roasted.

In the Dorr system, designed for coarse-grained feeds, cooling is controlled by recycled cold roasting gas injected into the upper part of the bed. In the INCO system a nickeliferous pyrrhotite containing 37% sulphur and 0·75% nickel is roasted at 800° C. The nickel in the roasted product must be soluble in ammoniacal liquor, so to avoid sulphatization the oxygen content of the roasting gas is reduced. Slurry at 90% *minus* 200 mesh enters the roasting chamber peripherally and a "flying bed" is maintained by means of a gas velocity of 1,100 cu. m. per sq. m. at grating. Gas and its load of entrained material are cooled in a combined boiler and cyclone unit, the trapped solids returning to the roasting chamber. Dust not trapped is caught in an electrostatic precipitation unit. One-fifth of the gas is led out separately to production cyclones. Thus with four-fifths of the roasting load in closed circuit with these cyclones a very high solids density is maintained with long overall residence. A roasting gas containing 13·5 vol. % SO_2 and 0·5% oxygen is feasible. The roaster treats 500 tons per day on a circular grate of 6·7 m. in a shaft which widens to 7·9 m. at the top, the height being 13 m.

The paper continues to describe experimental work on temperature effect, using a dispersion of pyrite in sand. The threshold roasting temperature is about 400° C. and results in copious sulphatization. As a single grain reacts the reaction product migrates into the substrate and this diffusion governs the situation. Pyrite converting to Fe_2O_3 is reduced 37% in volume, so that pores are formed. Sulphate formation, however, increases mol volume by 160%, so that the resulting dilation closes the pores and reaction stops prematurely, owing to the creation of a non-porous sulphate skin. The rate-determining step is controlled by the speed of this diffusion. At 500° C. the retardation disappears and roasting proceeds in accordance with the availability of oxygen. The decomposition pressure of iron sulphate prohibits its formation under these roasting conditions and reaction rate is therefore a function of free gas diffusion to the particle's interior. At still higher temperatures a surprising change takes place. Reaction stops *before* the required completing volume of oxygen has passed through the fluid bed. This is due to a sort of distillation of sulphur from the particle under the influence of heat, at a rate which more than exhausts the oxygen available for completion of reaction. Subsequent roasting can then only act on material impoverished of its sulphur to the point where further reaction cannot occur. These findings were made experimentally on 5 g. charges of pyrite in 100 c.c. of fluidized sand in temperature steps of 100° C. from 400° to 1,000° C. In Dr. Schytil's paper they are developed mathematically and the resulting equations are incorporated in a phase diagram for a fluidized bed. The roasting process, with respect to the roasting gas formed, is thus interpretable mathematically for an ideal material.

Under practical working conditions pyrite will be neither uniform nor pure, but will contain varying admixtures with such sulphides as those of arsenic, copper, lead, and zinc, apart from inert additions and grain-size variations. Special problems associated with such minerals are briefly discussed. The classic fluid-bed technique is unlikely to be feasible for the roasting of sulphidic lead or antimony, but for most other cases standard furnace designs can be adapted to special circumstances.

(6) *Corrosion.*

New Uses for Plastics

The Miami Copper Company, Arizona, is finding new applications for polyvinyl chloride plastic in its handling of acid leach liquor. Its most recent effort, described in *World Mining* for April, 1960, is a plastic raft which carries a pump, motor, and fittings weighing over 9,000 lb. The raft is constructed of 12 in. diameter plastic piping held in spacers made either of the same material or of redwood. The 100-h.p. pump delivers 700 gal. per min. against a 350-ft. head. Among other uses is the lining of flotation cells,

pipes, and pumps. One form, a vinyl plastisol, is applied as a heavy liquid and cured by baking. It thus provides a cheap coating for practically any metallic shape—for instance, as a coating on metal screens hitherto clogged by scale.

(7) *Automation.*

Chemical Engineering Practice

Writing in the *Engineering Journal* (Canadian) for February, 1960, R. E. Bark describes modern instrumentation in the chemical industry and in view of the increasing use of automatic control in mineral dressing a few points are abstracted.

Installed instrument costs today may exceed 10% of the total value of the chemical plant. An early point to be decided is the proposed location of the central control room with its main operating panel. The operator wants easy access to production and to technical supervision, while safety considerations may suggest reasonable remoteness from fire risks. The instrument engineer is concerned with accuracy of performance, which requires that the transmitter is located at the point where the measurement is made and this applies also to the control valve. Whether relay to the control station located on the main control panel is made by electric or pneumatic means, it is broadly desirable that the two are as close as is conveniently possible. The operator must be able to vary the conditions controlled by use of his control valve (or to by-pass the control system in special circumstances). This requires observation of the main panel, no matter where the controlling mechanism which responds to the valve may be situated. Again, since the monitoring device is at the measuring point and the correcting arrangements should be close to it, the tendency at design stage is toward a compact layout. Particularly with pneumatic signals, loops several hundred feet long, with the inevitable blurring set up by any distortion of the carrying pipes, leads to reduced efficiency and precision. Bundles of poly-ethylene tubing are favoured for the quarter-inch pneumatic transmission lines. These are available in bundles of up to 19 tubes, 1,000 feet long, each with its inbuilt telephone wires for checking purposes between control room and process area. Expansion loops are essential at intervals to deal with temperature effects.

A coded numbering system for ready identification during installation and maintenance is highly desirable. Air, reduced from 100 p.s.i. to 25 p.s.i., and dried is also needed. Suitable junction boxes and conduits are also planned at the design stage. Fire protection is studied, as a flash would melt the plastic tubing, and asbestos armouring is sometimes used. If climatic extremes are likely protection from freeze-up is advisable. The article ends by noting that the modern approach and materials of construction have considerably reduced costs and have improved operation during the past five years, but that considerable further development may be expected as the problems associated with automatic control of continuous plants become better understood.

Book Review

A Glossary of the Diamond-Drilling Industry. By A. E. Long. U.S. Bureau of Mines *Bulletin* 583. Paper covers. 98 pages. Price 35 cents. Washington : Superintendent of Documents.

Described as the first glossary ever prepared for the American diamond-drilling industry, this new Bulletin of the United States Bureau of Mines defines about 5,000 words and symbols. The glossary, it is stated, represents many years' work by the author, but experts in several professional and industrial fields have helped in selecting the terms and developing the definitions in an effort to promote a common language among manufacturers and users of diamond-drilling equipment.

Many distinctive words are found in the glossary, while the thousands of definitions included also recognize modern scientific attainments. An appendix contains tables comparing present and former standards established by the Diamond Core Drill Manufacturers Association and shows steps in developing nomenclature of diamond-drill fittings.

The author says that the first step towards preparation of the glossary was taken when the Association proposed its preparation to the Bureau of Mines in 1955.

☛ Copies of the books, etc., mentioned under the heading " Book Reviews " can be obtained through the Technical Bookshop of *The Mining Magazine*, 482, Salisbury House, London, E.C.2.

Engineering Log

Uses of high-velocity jet flames, of the same type as are used for propelling rockets, for mining and quarrying operations were recently demonstrated to Scandinavian quarry operators. With the high velocity of a rocket jet channelling and piercing equipment supplied by Union Carbide Europa S.A. of Geneva easily cut channels in granite, drilled blast holes, and gave an extremely attractive texture to granite surfaces. The basic process 'jet-piercing' was developed about 20 years ago for drilling blast holes in taconite iron ore which had for years been most difficult to drill with conventional mechanical drilling tools. The process produces the tremendous heat which is used to spall the granite and other stone by burning oxygen and kerosene under pressure. It is the spalling action, not melting, that produces the channel or the hole in the stone. Water is used as a coolant for the combustion chamber and burner nozzle and, in addition, quenches and embrittles any material in the rock which may have become fused by the jet flame. A large portion of the water turns to steam, which, together with the burned gases, carries the particles of disintegrated rock out of the hole.

* * *

A new viaduct in Aberdeen, South Dakota, is unusual in being the first major bridge in the United States to have a built-in electrical heating system in its deck. Other things about it are unusual too. It is equipped with aluminium handrails, lightweight concrete has been used for the deck as well as for its pre-stressed concrete girders, and the girders are supported not by steel bearing plates but by neoprene pads. The bridge has 20 bents made of pre-stressed concrete piles rising to a poured-in-place cap, a design used in order to avoid excavating near the railway tracks which the bridge spans. Because of poor bearing conditions some of the piles have been set on long steel tubes. The viaduct carries four lanes of traffic over 14 railway tracks. It is 1,311 ft. long, including approach slabs, and measures 915 ft. between abutments, the 19 spans ranging from 29 ft. to 80 ft. in length. A 3-ft. wall separates the two 26-ft. roadways and pedestrians use two 4 ft. 10 in. paths. Ten rows of concrete girders support the 6-in lightweight deck. The heating was designed primarily as a safety measure. During cold weather the $6\frac{1}{2}\%$ gradient would be hazardous without it and the hazard would be intensified by cross streets at either end of the bridge. With the heating the bridge should be safe for traffic under all weather conditions. The heating elements are embedded in the concrete beneath the wheel tracks in each of the four lanes available to traffic. Under each wheel track three $\frac{1}{4}$-in. copper tubes bear the elements at a depth of about $1\frac{1}{4}$ in. below the surface, being spaced at intervals of about 5 in. The heating elements are fed by large conduits embedded in the raised mall. It is not necessary for the elements to pass through the expansion joints, since each span carries a looped system. At either end of the bridge transformer banks supply 440-V power to the main lines and 1,208 amp. are expected to be required. The system has been so arranged that half the length of the bridge can be heated without the other half, allowing conservation of electricity when the bridge ices up on the north end only. All conduits, switch boxes, and heating elements had to be placed before the concrete was laid. Elements were wired to the top layer of reinforcing steel. The neoprene pads, which replace conventional steel plates as a support for girder ends, allow for slight expansion and contraction movements of the deck without showing the tendency to creep that steel bearing plates have. In addition, the pads deform slightly under pressure, reducing concrete spalling from bridge seats. A double thickness of metallic-reinforced neoprene pad is used under the longer girders and this is about 2 in. thick. The heaviest girder weighs only 22 tons for a length of 80 ft., compared with 34 tons for regular, instead of lightweight, concrete. The bridge is lighted by fluorescent light from aluminium light posts. The combination of aluminium and concrete on the exposed parts of the bridge is expected to make maintenance trouble-free for years, since no rusting will occur and no painting therefore be needed.[1]

* * *

A novel use has been found for vermiculite concrete in coal mines. It is being used in pits in No. 1 Area of the East Midlands Division, National Coal Board, for filling large roof cavities following falls of rock. These have to be filled to prevent further falls of rock and the build-up of methane gas with the consequent danger of fire and explosion.

[1] *Contractors and Engineers*, May, 1960.

It is the light weight of vermiculite concrete which makes it especially suitable for this purpose *plus* its unique feature of compressibility. The way in which vermiculite compresses and deforms enables it to act as a cushion as the surrounding ground presses on it and it will compact rather than shatter and crack. It absorbs the strata movement without distortion of the supports. Mixing of the vermiculite concrete can be quite simply carried out by untrained personnel. The mineral is being prepared and supplied by Dupre Vermiculite, Ltd., who worked with No. 1 Area headquarters to develop the application.

* * *

National Aeronautics and Space Administration has launched the most complicated package yet into orbit, to transmit an 850 sq. mile view of the weather to ground stations. " Tiros " has been developed for the U.S. Army Signal Corps, its name being an abbreviation of " Television Infra-Red Observation Satellite," and it is equipped with two television cameras to photograph changing cloud patterns which cover the earth. Later models will carry infra-red sensors to map out the relative temperatures of the earth's surface. The satellite's path circles the globe from west to east once every 90 min. approximately at an altitude of about 400 miles. Observations will extend over a belt from the latitude of Santa Cruz, Argentina, in the south to Montreal's northern latitude. It revolves at the rate of 12 r.p.m. and is expected, in a life of 90 days, to complete 1,300 orbits. Of the two TV cameras, one is equipped with a wide-angle lens, with wide scope but little definition, while the other pin-points small sections of cloud cover to provide detailed evidence. Both cameras will give data on hurricane and cyclone patterns and may even show individual cloud types, tornado breeders, and thunderstorms. The information obtained in individual photographs is stored on ½-in. magnetic tape, which runs at a speed of 50 in./sec. in specially-designed recorders in the satellite. The information is then fed, on receipt of a radio command, to ground stations in Hawaii and New Jersey. When the satellite is within range it can be commanded to transmit the current picture direct without tape intervention. The ground stations can also make their own photographs. The mosaic of accumulated Tiros evidence should make more accurate weather forecasts possible, both immediate and long-range.[1]

* * *

On the initiative of the British Standards Institution, the Protective Headwear Manufacturers Association, and other safety interests, a new committee of the International Standards Organization has been set up and is to hold its first meeting later this year at British Standards House. It is to be attended by helmet makers, safety organizations, and government representatives and others interested from many parts of the world. The aim of the committee, it is stated, will be to agree on world standards for the quality and testing of safety helmets. Firms in the United Kingdom believe that as a result of years of research and testing by manufacturers and independent testing laboratories in the U.K. the present British Standards for motor-cyclists', racing car drivers', and industrial workers' helmets are among the highest in the world and they naturally hope that any recommendations which the new international committee evolves will be substantially in line with existing British practice.

* * *

A new revolving ship crane built in Milwaukee, Wisconsin, is capable of moving up to 3,700 lb. of cargo every 40 sec., or 11,200 lb. a min. exclusive of time for hooking cargo on and off the crane. The new " Cargomaster " is built by the Unit Crane and Shovel Co. and is the product of three years' research. It is claimed that the crane will load cargo faster than any previous ship crane of the revolving type ; give pin-point accuracy ; luff loads between 55-ft. and 14-ft. radius with no more than *plus* or *minus* 5 in. variance from a horizontal load path ; operate with a ship list in excess of 5 degrees of list ; weigh and cost less than conventional gear on average installations; reduce and simplify maintenance, and reduce installation costs in comparison with king-post cranes. The new crane is rated at 5 long tons capacity and can handle this load at distances up to 55 ft., with a 57-ft. boom 18 degrees from the horizontal. This means that on many ships a single centreline crane can replace conventional gear on both port and starboard sides of the hatch. If 30 sec.

[1] *Electronics World*, June, 1960.

hook-on and hook-off is allowed on each load the new crane could move 51 loads of 3,700 lb. an hour over a typical path, or 40 loads of 11,200 lb., giving a theoretical loading capacity of 200 long tons per hour with loads of 5 long tons. Speed of handling must be coincident with the operator's ability to judge clearances with bulky loads. On the empty-hook journey maximum speed can be slightly above 375 f.p.m. Loaded-hook travel speed will decrease with increase of load above 3,700 lb. At full payload a speed of 125 f.p.m. is obtainable. Instead of the conventional 5 points of speed selection an infinitely-variable speed selection device has been provided, so that the operator can judge precise speed for the particular load. Slewing speed up to 3 r.p.m. maximum, and also luffing, are also infinitely variable. With horizontal load path almost perfect the crane can move a load from 55 ft. reach to 14 ft. reach in 13 sec. under complete and effortless control of the operator. All motions are operable simultaneously or separately, with independent speed for each motion. All moving machinery, including the crane motors, generators, master controllers, gear housings, and cable drums is housed in a sea-and-weather-tight enclosure and the crane rests on a ball-bearing ring gear which allows wide spreading of reactive load forces. This base consists of a 90-in. diameter ball-bearing with internal bull gear cut in the fixed race. The crane rotates through a 360-degree arc, using 2-in. steel balls, with minimum friction loss, resulting in a lower power requirement for slewing. The large slewing race obviates the necessity for a kingpost and so reduces crane diameter to 9 ft. and removes obstructions to cargo holds.[1]

News Letters

BRITISH COLUMBIA

July 11.

Mineral Production.—The Province's production of the principal metals—gold, silver, copper, lead, and zinc—during 1959 was valued at $93,442,599 ; miscellaneous metals, including iron ore, nickel, tin, and minor metals recovered at the Trail smelter, had a value of $11,068,014. The above information is contained in " Lode Metals in British Columbia, 1959," issued in advance of the annual report of the Minister of Mines for the Province. The total quantity of ore mined at all lode mines amounted to 6,989,760 tons and came from 60 mines, of which 44 produced 100 tons or more. The average number employed directly in the lode-mining industry in 1959 in mines, concentrators, and smelters was 7,300.

During the year 26 mills were operated, 14 throughout the year and four on a temporary basis. One major mill closed, three re-opened, and four commenced operation for the first time. Of the intermittent operations mills at Ainsworth and Sandon accepted custom ore. The Toric mill was shut down when the ore-bodies were exhausted at Alice Arm. The new mills included a small plant on the Golconda molybdenum-copper property, a 1,000-ton plant at Phoenix, and two iron-ore concentrators on Vancouver Island. Britannia, Giant Nickel, and Woodgreen mills re-opened after various degrees of re-organization.

The Trail smelter recorded custom receipts of 3,871 tons of ore from 23 properties, 3,026 of which obtained a silica bonus in excess of the treatment charge. The smelter also recorded custom receipts of 3,944 tons of lead concentrates and 16,417 tons of zinc concentrates ; totals of approximately 19,370 tons of lead concentrates and 16,417 tons of zinc concentrates were shipped out of the country for smelting. Copper concentrates were shipped to the Tacoma smelter, with the exception of the output of Cowichan Copper and the copper concentrate recovered by Taxada Mines, Ltd., which went to Japan. Nickel concentrate went to the Fort Saskatchewan refinery in Alberta. All iron-ore concentrates, amounting to 849,248 tons, went to Japan.

Portland Canal.—Following a vigorous outside exploration policy initiated in 1959 Granduc Mines, Ltd., staked some 500 claims along the Unuk River about 20 miles north and north-west of the Granduc mine. Close prospecting is being conducted for the current season.

Silbak Premier Mines, Ltd., is earning a substantial income from lessees, who are extracting and shipping high-grade ore from an abandoned glory hole. Two spectacular shipments were made late in 1959 and weekly despatches of not less than 50 tons have been made since the middle of April, 1960. The high-grade nature of the ore in the current year is revealed in Table 1. No further final returns had been received at last report. The fifth shipment was made to the Trail smelter, but all others both before and after have been made to the American Smelting and Refining Co., at East Helena, Montana. McQuillan and associates, the lessees, have until September 23 to continue their mining and shipping operations, after which time the Silbak Premier company will take over. The company's president, Mr. A. E. Bryant, told the annual meeting that the company would continue shipping high-grade ore from the surface workings for the balance of 1960, but would pursue the further development and mining of what appears to be a parallel ore-shoot to the most productive veins in the mine by underground methods thereafter.

Vancouver.—During the period from resuming operation early in the year to the end of 1959 the Britannia Division of the Howe Sound Company milled 300,946 tons of ore and recovered 11,198 tons of copper concentrate and precipitate, 2,919 tons of zinc concentrate, and 35,488 tons of pyrite tailing. Production therefrom was 3,174 oz. of gold, 28,888 oz. of silver, 6,826,741 lb. of copper, 64,539 lb. of lead, 3,369,927 lb. of zinc, and 16,053 lb. of

[1] *Marine Engineering Log*, Jan., 1960.

Table 1

Shipment No.	*Dry Tons*	*Gold oz.*	*Silver oz.*	*Lead %*	*Zinc %*	*Copper %*	*Lessor's Royalty*
1 . . .	56·27	8·17	263·9	4·45	9·0	0·9	$4,074
2 . . .	59·76	7·16	204·7	4·3	7·9	0·87	$3,563
3 . . .	54·45	6·28	171·4	4·2	7·9	0·75	$2,768
4 . . .	73·65	5·45	149·15	3·6	6·8	0·60	$3,214
5 . . .	57·31	6·49	165·75	4·5	8·8	—	$2,856

cadmium. Ore was obtained from remnant pillars in the Victoria and No. 8 ore-bodies and was mined by shrinkage, cut-and-fill, and filled square-set methods. Mill methods were changed from wet to dry feed in the initial circuit.

Vancouver Island.—International Iron Mines is preparing the Ford magnetite deposit at Zeballos for production early in 1961. Machinery and equipment valued at $500,000 had already been placed on the property, open-pit mine and mill sites have been cleared, and crushing and beneficiating plants and deep-sea shipping facilities are being constructed. The company will mine 3,200 tons of ore daily to recover 2,600 tons of 62% iron concentrate, the grade of reserves being 48% iron. The open-pit will be established on fairly level ground at elevation 2,800 ft. Ore is to be broken by long-hole vertical drilling and dropped through rises to chutes to be constructed on an adit at 2,050 ft. elevation. It will be conveyed to portal by locomotives and ore trains, thence to the concentrator at 500-ft. elevation by surface tramway. The property was acquired under option from Anyox Metals, Ltd., a wholly-owned subsidiary of Frobisher, Ltd., which had performed preliminary work. International Iron has been fortunate through the availability of houses and buildings constructed during the gold boom of the 'thirties. Among these is the former Golden Gate Hotel, which will be utilized to house 60 men. At present 30 are employed on construction. International Iron Mines also holds a 50% interest in partnership with Noranda Exploration Co., Ltd., in the Bugaboo iron property, also on the west coast of Vancouver Island and some ten miles north of Port Renfrew. Diamond drilling aggregating 4,500 ft. was done on this last year. International Iron is also half owner of Nimpkish Iron Mines, Ltd., which is shipping iron concentrate from Nimpkish Lake, near the north end of Vancouver Island. The partner in the Nimpkish operation is the Standard Slag Company of Ohio. All iron concentrate from B.C. coast operations is exported to Japan.

Highland Valley.—Sumitomo Metal Mining has paid $100,000 for an option to purchase the 5,000-ton mill and surface plant of Manitou-Barvue Mines, Ltd., in Quebec, for a total price of $1,500,000. At the same time Sumitomo has paid $350,000 cash for 300,000 shares of Bethlehem Copper Corporation, partly as evidence of good faith in its negotiation to bring the Bethlehem copper property into production and also to finance Bethlehem in further development At present drilling is proceeding in the " A " zone, situated between and about equidistant from the Jersey and East Jersey zones, in which several million tons of reserves have been established. The grade of ore in the new zone appears to be 12% higher than in the Jersey zone and Mr. M. A. Cooper, consulting geologist, states its central position can be worked in advantageously to any overall surface-stripping plan. Metallurgical investigation has established that a 30% copper concentrate can be attained through fine grinding and with recovery of 85% to 92%. Sumitomo has been given until February 28, 1961, to elect the scale of operation but a definite production date of September 1, 1962, has been set in the agreement. It is planned to reconstruct the Manitou Barvue mill on the Bethlehem property.

Nicola.—Work has commenced on a contract let by Craigmont Mines to Peter Kiewit and Sons of Canada, Ltd., to move 1,500,000 cu. yd. of dirt and 1,200,000 cu. yd. of rock in preparation for open-pit mining near Merritt. It is stipulated that the project, which will require approximately 100 men, must be finished by the end of February, 1961.

Trail Creek.—The Sullivan concentrator of the Consolidated Mining and Smelting Co. of Canada, produced 119,360 tons of lead concentrate, 254,330 tons of zinc concentrate, and 407 tons of tin concentrate from 2,440,396 tons of ore milled in 1959. In the same period the company's H.B. mine at Salmo produced 5,033 tons of lead concentrate and 37,253 tons of zinc concentrate from 463,504 tons milled and the Bluebell mine at Riondel produced 14,161 tons of lead concentrate and 29,981 tons of zinc concentrate from 251,366 tons. The company's Fairview mine at Oliver provided 26,717 tons of silica ore for fluxing purposes. No cadmium production is listed for the Sullivan mine although the Trail smelter produced 838 tons during 1959 and the Sullivan mine was the principal source of the metal. No gold production is shown for either the H.B. or the Bluebell and no copper output is recorded for the H.B.

Revelstoke.—Transport obstacles have compelled Mastodon Zinc Mines to operate at only one-half of mill capacity since resuming production in mid-May. However, it is expected to reach full capacity of 200 tons daily by the end of August. It is also hoped to increase current mill-heads of 12% zinc by at least 25% as soon as transport difficulties are overcome. The full operation engages 50 men. The company is controlled by Highland-Bell, Ltd.

Golden.—Preliminary figures released by Sheep Creek Mines show a net profit of $401,625 in the year ended May 31, 1960. This compares with $223,246 in the previous year. The company had income of $1,553,916 made up of net smelter returns of $822,887 from lead and $660,578 from zinc, *plus* $70,451 from barite sales, for a net return of $7·84 per ton ($6·22). During the year the company mined and milled 188,681 tons of lead-zinc ore and 9,407 tons of barite ore.

New Zealand, South Pacific Mines.—This company is now reclaiming the Waitangi gold mine at Thames and meeting with gratifying success. Mr. Alfred R. Allen, resident technical representative, has reported rehabilitation of an 800 ft. length of adit on the No. 2 level, within which an ore-shoot 410 ft. long has averaged 0·6 oz. gold per ton with indicated width of 10·0 ft. The drive is 400 ft. below surface.

EASTERN CANADA

July 20.

Ontario Gold Output.—During May the 30 producing gold mines in Ontario reported milling 784,391 tons of ore, the yield being 225,550 oz. of gold and 32,174 oz. of silver, valued at $7,765,153.

Sudbury.—The operations of Renabie Mines, in the Missanabie area, in the first three months of the current year show a total of 47,453 tons of ore milled for a recovery valued at $403,441.

Manitoba.—In the first quarter of the current year Sherritt Gordon Mines made a profit of $962,000. Nickel production at Fort Saskatchewan during the quarter was 8,389,314 lb. of which 1,690,392 lb. were produced from custom concentrate. Lynn Lake 289,348 tons of ore was treated during the first quarter for an average of 3,180 tons per day. A new ore-body picked up on the 2,000-ft. level at the Farley shaft extends upward to just below the 1,550-ft. level.

The Hudson Bay Mining and Smelting Company reports a profit of $3,083,479 for the first three months of the current year, the value of metal production for the period being given as $12,402,633. The Coronation mine, near Flin Flon, came into production on April 1 at a rate of 1,000 tons per day, but two weeks later the Birch Lake mine was closed down. Development work was continuing at the Chisel Lake property which is expected to start production later this year.

Saskatchewan.—The operations of Gunnar Mines in 1959 resulted in a profit of $8,951,234. Uranium sales in the year totalled $20,974,251. Arrangements were completed for the delivery of 3,550,000 lb. of uranium oxide on the unfulfilled parts of Canadian Dyno Mines and Rayrock Mines contracts.

Grouting operations by the Cementation Co. (Canada) have reduced the water flow into the production shaft of the potash property of Potash Company of America near Saskatoon to about 25 gall. per min. from the former rate of 350 gall. per min. The flow had caused a halt in operations at the property last autumn. It is expected the repair project will cost about $1,000,000. The shaft was put down to a depth of 2,500 ft. late in 1958 by use of a freezing process.

It is reported that Eldorado Mining and Refining plans an addition to the Beaverlodge steam plant as well as alterations in the mill. In addition it is proposed to deepen one of the shafts and, possibly, to sink a new one. The programme contemplated is expected to cost $865,000.

Black Bay Uranium shipped 6,496 tons of ore from its Fishhook Bay property to Eldorado Mining and Refining's mill during the first quarter of the current year. Revenue from the shipments totalled $138,827. The ore was from the first level at the Fishhook property where a length of about 200 ft. has been developed. The present Eldorado contract requires delivery of 176,000 lb. of uranium oxide by March, 1962. However, new discoveries of higher-grade material may make it possible to apply for an extension of contract.

Quebec.—In the first quarter of 1960 Noranda Mines earned a profit of $2,942,000, metal production amounting to $8,134,000.

At Sigma Mines an internal shaft is going down from the 24th to the 30th level. It will cost about $1,200,000, of which $500,000 has already been spent in preparatory work. A further $300,000 to be charged directly to operations is expected to be spent during the remainder of 1960. It is hoped to have the new opening down to the 29th level by the year end. Ore reserves have declined since the end of 1959 but are expected to increase next year when development is started on the new deep levels.

AUSTRALIA

July 20.

Mount Isa.—The financial year at Mount Isa closed on June 30 with increased production of ore amounting to 409,507 tons, or 17% on the previous year, the results constituting a record. During the year lead ore treated decreased by 146,986 tons to a total of 922,416 tons, but the copper ore treated rose to 1,914,656 tons, an increase of 558,493 tons. Silver-lead-zinc ore treated was 773,430 tons.

There will be great interest in Mount Isa during August when the annual meeting of the Australasian Institute of Mining and Metallurgy is to be held there. The company's copper refinery at Townsville, the Mary Kathleen Uranium mine and the Mount Morgan mine are to be visited. The meeting has attracted the record attendance of 720 delegates, which has introduced some problems in transport and accommodation in that remote region. The president of the Institute is Mr. G. R. Fisher, chairman of directors of Mount Isa Mines, Ltd.

Western Australia.—Despite the price of gold and continually rising costs the State gold-mining industry continues a fair rate of dividend, only made possible by the efficiency of the mines in the State and also by capable management. The situation is particularly difficult as the industry has to face steady increase in wages and in the cost of all stores and materials. Dividends paid by gold producers in Western Australia in 1959 were £A 2,093,984 or £A26,158 higher than in 1958. During the year ore treated totalled 2,959,202 tons, a fall of 61,870 tons on the previous year, and gold output decreased by 13,850 oz. to 860,969 oz. of fine gold; the value of the production was £A13,452,643. Recovery was 5·82 dwt. per ton, as compared with 5·79 dwt. in the previous year. It is intended by the Chamber of Mines of Western Australia to present a further case for assistance to the Commonwealth Government at a later date based on broader lines than in the past.

The old Sons of Gwalia mine is putting up a good fight for rehabilitation and the last financial year closed with a profit of £30,808, which compares with a profit of £41 in 1958. The result was achieved by the treatment of higher-grade ore and the improvement in grade is also indicated in the ore-reserve figures. Ore treated amounted to 153,138 tons and gold recovery was 33,547 oz. of fine gold. The State Government has agreed to a further postponement of loan repayment, the total being £295,388. Ore reserves at December 31, 1959, were 237,100 tons, with an average grade of 5·06 dwt., which compare with 230,000 tons and 4·89 dwt. in 1958. There have been several promising developments on various levels and on new lodes between the No. 8 and No. 12 levels. On the No. 27 level a rise was put up 185 ft. in values averaging 13·6 dwt. over 72 in. On No. 12 level the south drive off the west cross-cut, 1,000 ft. south, was advanced 213 ft. in ore with a value of 5·4 dwt. over 96 in. and a rise at 1,060 ft. was put

up 94 ft. in values of 7·6 dwt. over 72 in. The new crusher installation has reduced costs by 1s. 4·48d. after absorbing increased wages.

Oil Refinery.—The B.P. Refinery at Kwinana, Western Australia, is to be increased in capacity at an anticipated cost between £A8,000,000 and £A10,000,000. The possible foreign currency saving is expected to approximate £A2,500,000. Lubricating oil blending for Western Australian markets will be done in the State. The new plant will have a capacity of 100,000 tons and will be the third largest B.P. lubricating-oil plant, the other two being in Kent, with 180,000 tons, and South Wales, with 125,000 tons. Favourable factors influencing the selection of the site in Western Australia were the satisfactory labour position and the assistance given by the Western Australian Government.

Broken Hill.—Broken Hill South, Ltd., has been very active in prospecting the district outside its own leases, but particularly within its own property. For some time serious prospecting has been carried out in a mineralized zone underlying the city of Broken Hill and the work is the most extensive yet done in the area. Before abandoning its silver-lead-zinc leases the Broken Hill Proprietary Company diamond drilled from the bottom level of the Delprat Shaft area, with the object of locating repetition of the favourable lode beds, but without success. Success in the South Mine in drilling westward and in locating an extensive mineralized zone directed operations to the northern extension of this zone; exploration here may lead to the discovery of a new payable ore-body which would substantially prolong the life of the company. The company's surveyors believe that the new ore zone and the deeper lode beds will extend below the city from south to north. Broken Hill South has already spent about £A750,000 in the exploration programme.

New Zealand.—The possibility of utilizing the very extensive occurrences of titaniferous iron sands along the coasts of New Zealand has been given very serious attention. Investigation by combined Government and private enterprise has been abandoned and from now the operating company will be wholly a Government activity. To this end the Government is now to take full control of the investigation company, which will be established as a State enterprise with a capital of £NZ250,000. The investigations are expected to take three years and if the work is satisfactory it is stated that the way will be open for private concerns to participate in the ultimate enterprise, which will need capital of £NZ30,000,000. The company will engage overseas consultants in the investigation of the problem.

The Dominion is hopeful that an aluminium smelting industry, using bauxite from the great Weipa deposit on Cape York Peninsula, in North Queensland, may be established. The country offers potential hydro-electric power and coal in the near vicinity, as well as adequate harbour facilities close to the suggested site for the works. The Consolidated Zinc Corporation has been looking into the power possibilities of Lakes Manapouri and Te Anau in the South Island. A Bill has now been introduced into the House of Representatives validating an agreement between the Government and Consolidated Zinc, which gives the right to that company to use the waters of the Lakes as well as that of the Waiau and Mararoa rivers for the generation of power for the development of the industry.

Tasmania.—The future of the Bell Bay, Tasmania, works of the Australian Aluminium Production Commission has been a matter of serious consideration for several months. The Commonwealth Government wished to relinquish its interest in the venture and efforts to interest private organizations in a partnership with the Tasmanian State Government, which shared ownership with the Connonwealth Government, appeared to have been unsuccessful. It is now reported that an agreement has been made between the Commission and the Swiss company, Aluminium Industrie A.G., for supplying technical services for the installation of additional plant at the Bell Bay smelter. The production is to be increased from an annual capacity of 12,000 tons to 16,000 tons. This extension will be financed by the Tasmanian Government, the Commonwealth Government's partner, and will cost about £A2,800,000. Modern electric furnaces are to be installed and the work will take about three years to complete. The increased capacity will enable the plant to produce aluminium ingot at a lower cost and a further expansion of the plant to 28,000 tons annually is planned. At the present time the works is importing Malayan and Indonesian bauxite, but it is considered that when production at the Weipa bauxite field is practicable Weipa ore will be used at Bell Bay.

Broken Hill Proprietary is to establish a ferro-alloys plant in Tasmania on a site on the Tamar River, near Launceston, and adjacent to the aluminium works at Bell Bay. The new plant is expected to commence production early in 1962 and will have an annual capacity of 26,000 tons of high-carbon ferro-manganese. The new B.H.P. subsidiary is known as the Tasmanian Electro Metallurgical Co., Pty., Ltd. A contract has been arranged with Elektrokemist, of Norway, for a 13,200-kW ferro-manganese furnace at a cost of £A500,000. Elektrokemist in addition to supplying the furnace will also supply auxiliary equipment and will be responsible for the planning of the plant. A considerable part of the equipment will be manufactured in Australia.

Whyalla.—Broken Hill Proprietary is engaged on projects asssociated with the steelworks at Whyalla, South Australia, which will involve an expenditure of £A4,300,000. The largest item of expenditure will be £500,000 for the standardization of the works railway system and improvements in works roads. Extensions are to be made to wharfage and an additional alternator and an electrostatic precipitator at the blast-furnace are to be erected at a cost of £906,000. Capacity of the new alternator will be 15,000 kW and this unit will increase capacity of the power house to 30,000 kW. The precipitator, costing £A71,000, will clean carbon monoxide by-product from the blast-furnace gas for use as fuel for powering the generator.

Uranium.—The South Alligator uranium mine, in the Northern Territory, appears to be developing favourably and a recent report advises new disclosures of good-grade pitchblende ore east of the Rockhole workings; these developments indicate that the ore zone extends for another 1,000 ft. eastward. This extension is being explored with two new levels. The Rockhole No. 1 level has passed through pitchblende ore from 375 ft. to 408 ft. and good-grade ore has been opened up in the opposite direction from the drive. Regular shipments of uranium oxide are being made to the United Kingdom.

King Island.—The King Island Scheelite mine was closed down in August, 1958, after the price for tungsten fell to an unprofitable level. The company has now entered into a contract of two years' duration for the sale of scheelite concentrate and the mine, which had been previously re-opened on a limited scale in November of last year, to meet scheelite deliveries, will now be able to increase production substantially. The treatment plant will be operated for five days per week on a 24-hour basis. During active operations before the closing down profit approximated £A1,000,000 per year under the then existing contracts.

Lake George.—The Government of New South Wales is concerned over the future of the Lake George Mines, where the shrinkage of ore reserves has indicated the approaching end of production ; they were equivalent to two years' supply to the mill unless further ore was discovered. The Department of Mines regards the mine, which produced lead, zinc, and copper, as an inportant asset to the State and Government officials are examining the position before discussing the matter with the Bureau of Mineral Resources. The possibility of locating additional ore reserves which might keep the mine in production will be examined. Lake George Mines have been worked continuously for more than 20 years.

FAR EAST

July 16.

End of the Emergency.—On July 31 the 12-year war against the Communist terrorists in Malaya's jungles ends officially. In the period the tin-mining industry has had to pay (Malayan) $30,000,000 in protective and security measures alone. In addition terrorists killed 53 mining workers and injured 55. A report in the *Straits Times*, giving some figures, goes on to say that the industry, as the second biggest revenue producer (to rubber) was one of the main targets of the terrorists, 97 attacks being made on mines spread throughout the country but mostly in Perak. The first Communist attack on a tin mine was on July 1, 1948, when the Phin Soon mine at Batu Gajah was raided and the last was on September 20, 1956, when terrorists raided the Lian Thi mines at Tronoh.

The biggest losses suffered by individual mines were by the French Tekka mines at Kampar, where terrorists caused (Malayan) $400,000 worth of damage on September 9, 1950, and by the Chinese-owned Yong Fan mines, also at Kampar, where $100,000 worth of damage was done on June 21, 1950.

Throughout the Emergency Malayan mines produced an annual average of 55,200 tons of tin and during the same period the Government collected $610,000,000 in export duties. One feature of the struggle was the setting up of the Kinta Valley Home Guard—for the protection of 227 Chinese-owned mines in that district. The rank and file of this Guard—the only one of its kind—was composed of Chinese, who were armed, trained, and put into uniform. Because of shortage of arms in the early days of the Emergency the F.M.S. Chamber of Mines imported 1,446 weapons (sub-machine guns, sawn-off shotguns, and revolvers) and 250,000 rounds of ammunition for the protection of miners and their property. The cost of the total damage to all the mines attacked by Communists is not known, but 36 of the mines attacked estimated their damage at $1,100,000.

Tin Industry.—Mr. P. L. Melliar-Smith, Malaya's Chief Inspector of Mines, before retiring under the Malayanization scheme has given his views about the future of the country's tin industry. The time of " easy pickings " on the tinfield are gone, he said. " At the turn of the century, when the industry began to get under way on a big scale, a yield of five katies of tin concentrates for every yard of earth treated was considered average. When I came to Malaya in 1937 the yield was down to half a kati. Now it is much less ". The answer, he thinks, is to employ more and more modern techniques in working the extensive low-grade deposits, whether in new ground or in tailings inefficiently treated in the past. It was this latter factor which had caused the Mines Department to oppose plans for developing worked-out mining areas into housing estates and parks. The Department's research division was constantly seeking to increase the industry's efficiency, he said, and its work on the use of hydrocyclones and jigs had enabled Chinese miners to work lower-grade areas economically.

Mr. Melliar-Smith said Malayanization of the Department would be completed by 1964, when the last of the 20 officers now being trained overseas returned. Mr. Melliar-Smith's successor is Mr. J. R. Lee.

Prospecting.—Following the reports on the aeromagnetic surveys in Malaya the main concentration of activity recently has been in Kedah State, where Japanese experts have been watching the hunt for fresh deposits of iron ore. Several licences have been issued for prospecting in Kedah, although a promising section which has been ruled out is Sungei Gurun because it is a domestic water catchment region. The bulk of ore traces detected during the aerial survey were on the 3,992-ft. Kedah Peak, where two mines are already operating on the lower slopes ; it looks as if the area for future operations will be further up the slope. However, there is a possible snag from the mining point of view since Kedah Peak is considered by many to be a national beauty spot which should not be disfigured. The Kedah Government will have to decide on the future of mining in the area.

Tin Council Representatives.—Sir Vincent del Tufo is to continue as Malaya's permanent representative on the International Tin Council until the end of 1961. This was stated in Parliament in Kuala Lumpur by Inche Mohamed Khir bin Johari, Minister of Commerce and Industry in reply to a question. The Minister had been asked whether a Malayan could be found for the job and he replied that the Government had decided to extend Sir Vincent's contract till the end of 1961 for the sake of continuity. It seemed inadvisable to make a change when the present tin agreement was ending and a new one was being drafted.

Diamond Rush in Borneo.—Thousands of people have swarmed through jungles in central Borneo recently in a search for diamonds, according to a report from Jakarta, Indonesia. They have been heading for the Kahaju Hulu district, following a report that four men had found diamonds in a shallow stream in Sungai Pinang village when they were washing vegetables.

SOUTHERN AFRICA

July 28.

Economic Advisory Council.—The composition of the Economic Advisory Council to the Government has been announced and its first meeting took place on July 26. That was to deal with the Prime Minister's declaration of policy on the industrial development of the areas bordering on the Native Reserves, or Bantustans, and the establishment of the permanent committee for the location of industry and the development of the border areas. The Council chairman is Dr. D. H. Steyn, former Secretary of the Treasury ; members are Dr. M. H. de Kock, Governor of the Reserve Bank, Dr. H. J. van Eck, chairman of the Industrial Development Corporation, Dr. S. P. du Toit Viljoen, deputy-chairman of the Board of Trade and chairman of the permanent committee ; specialist members include Mr. V. Atkinson, Mr. P. Frame, Mr. H. Goldberg, Professors D. H. Houghton and C. G. W. Schumann, Drs. M. S. Louw and M. D. Marais, and Mr. J. G. van der Merwe : the Chairman of the Public Service Commission, the Secretaries of Labour. Agricultural Economics and Marketing, Commerce and Industries, Finance, Bantu Administration and Development, and Mines, the general manager of the South African Railways, chairmen of the Board of Trade and Industries, of the Wage Board, the Industrial Tribunal, the Registrar of Financial Institutions, and the chief official of the Economic Section of the Department of External Affairs. Other members include representatives of the Transvaal and Orange Free State Chamber of Mines, the Associated Chambers of Commerce, the S.A. Confederation of Labour, the S.A. Trade Union Council, the S.A. Agricultural Union, Confederation of Employer Organisations, S.A. Federated Chamber of Industries, and the Afrikaanse Handelsinstituut. As the name of the council suggests, its function is essentially advisory in relation to Government policy. It will therefore provide a channel of communication, immediately at hand, between interests representing the organized sectors of the country's economy and overseas interests established in the country on the one hand and on the other the State. It represents something therefore for which many of the organized sectors have been seeking, but has taken a form which many, according to reports, view with some concern, yet which equitable handling may assuage with time.

Union Finances.—The national income of the Union in the 1958–59 year improved further to £2,027,000. In 1959 the gross national product was valued at £2,427,000 against £2,320,000 in 1958, but whereas in 1958 there was an adverse balance of £74,000,000, this was reversed in 1959 to a credit balance of £79,000,000, mainly due to reduced imports and increased exports, which more than offset the outflow of private capital. While in 1959 there was this net current surplus, there was a net capital outflow of £37,000,000, due to repayment of short-term external loans and repatriation of external capital. The net outflow of capital was, however, increased substantially in the first 1960 quarter, mainly as repatriated external capital, as the result mainly of sales of South African securities by external holders. These sales and relatively higher imports were reflected in reduced gold and exchange reserves. More recently the adverse factors have been eased somewhat, but there has not yet become evident a recovery in the gold and exchange reserves.

Coal Mining Resumed.—Following an appeal to a Commission appointed by the Government Mining Engineer, which was upheld, the five sections of the South African Coal Estates (Witbank), Ltd., have resumed operations. The suspension of operations was ordered on the grounds that workings were being advanced over undermined ground. The commission found that the pillars can be regarded as stable under present conditions, but that there was need for special care in operations projected by the company, particularly in view of the possibility of conditions altering.

Transvaal.—Winkelhaak Mines is conducting pre-sinking cementation of the area where the projected No. 2 Shaft is to be sunk in the south-eastern section, about 6,000 ft. north-east of No. 3 Shaft. The new shaft will be 23 ft. lined-diameter and sunk to about 4,300 ft. in a programme which will raise the milling rate to the range of 150,000 to 180,000 tons a month. Reef development results have continued above the average to June 30, 1960, this average being 74·3% payable averaging 471 in.-dwt., with the second quarter's payability being 88% averaging 565 in.-dwt.

Buffelsfontein Gold Mining, which milled an average of 147,000 tons a month in the second quarter, has commissioned part of the extensions to the gold plant, which will raise the capacity to 200,000 to 240,000 tons a month. A further rise in the milling rate is therefore in prospect. Pre-sinking cementation is proceeding at the site of the new shaft in the eastern section.

Western Deep Level is rapidly extending development on the Venterdorp Contact Reef horizon from its ventilation component of the No. 3 Shaft system. All sampling to date has been conducted in reef development from the drive advance from the West Driefontein mine immediately to the north. More recently payability has improved but has remained relatively low, possibly due to the known somewhat erratic mineralization on this horizon and the proximity of current reef development to the sub-outcrop zone. Limited drilling in the lease area indicated a grade range of about 250 to 300 in.-dwt. in the Contact Reef, but this may be comfortably exceeded at depth from the sub-outcrop zone. The underlying Carbon Leader Reef is expected confidently to be of a much higher and more consistent grade.

Hartebeestfontein has virtually exhausted its accumulated residues held for uranium oxide extraction. However, this has been more than offset by the advance in the milling rate, which has already reached a tonnage adequate for the uranium sales quota of the company.

The projected site of the second shaft to be sunk by Zandpan Gold Mining is about 4,800 ft. west of No. 1 Shaft and is about 6,000 ft. from the western boundary, which conforms more or less with the major Buffelsdoorn Fault, on the eastern side of which the Vaal Reef horizon is very considerably downcast. The upcast body does not fall within the lease area, but is doubtless included in the company's mineral rights. The second shaft site is in or near another fault zone, on the downcast eastern side of which side the reef occurs at more than 6,000 ft. The depth of the new shaft will probably be about the same order of the first—namely, 7,500 ft. Its projected site is about 5,000 ft. north of the Western Reefs area ; No. 1 Shaft is about 4,000 ft. north of

Sewa River Diversion, Sierra Leone.

the Vaal Reefs boundary. Underground layout and operations may therefore be planned to tie up with operations and ventilation in the northern Western Reefs and Vaal Reefs areas. A borehole is being drilled at the projected site of the new shaft to obtain geological structural information.

Orange Free State.—Western Holdings is to convert its single northern No. 1 Shaft to a twin-shaft system, by sinking a circular 20-ft. lined-diameter shaft to a depth of 4,500 ft. in adjacent ground for upcast ventilation and by converting the existing rectangular shaft—bratticed for down and upcast ventilation—into a fully downcast unit. The high-temperature gradient of the ground in the Free State goldfield, particularly below the lava, and the need to provide additional ventilation for extended operations in the northern section are the reasons for the upward modification of the ventilation system and capacity in the section, which will be double the present rate when the new circular shaft will have been completed, sometime in 1962, at a cost of about £800,000. This will be financed from profits without, it is expected, necessitating a reduction of the current dividend rate. Somewhat east of the No. 1 Shaft is the major Dagbreek Fault, beyond which on its eastern side the reef is considerably upcast. West of the fault the reef dips more or less uniformly eastwards. The increased ventilation to be made available will facilitate the extension of development eastwards from No. 1 Shaft up to the Fault and of exploratory development further east, in the upcast zone, as well as opening up the shallow, sub-outcrop zone of the north-western section.

In the lease area of Free State Geduld Mines, Ltd., development and drilling has indicated that the very high-grade reef zone in the south-western section south-east, south, and south-west of No. 1 Shaft is to a major extent upcast to higher elevations than was previously thought. This would have involved extensive crosscutting at high cost from the existing workings for the exploitation of the section. Accordingly it has been decided to convert the ventilation shaft, nearing completion about 4,000 ft. south of No. 1 and near the common boundary with the north-western section of Western Holdings, into a twin-shaft system by sinking a 24-ft. lined diameter circular shaft to a depth of 5,000 ft. adjacent to the ventilation component mentioned, which new shaft will serve as the hoisting component.

With the two shafts in the south-eastern section of Free State Saaiplaas having only recently been connected, development of a sufficient number of faces on the Basal Reef has not been carried far enough for the previously scheduled start of milling. This has now been deferred to October this year. To finance the continuation of operations and provide for the extension of the gold plant capacity to the 100,000 to 120,000 tons a month range from 60,000 to 72,000, the company is to issue 6,000,000 shares at par in the immediate future. A syndicate headed by Consolidated Gold Fields of South Africa, Ltd., is to subscribe for at least half of the proposed issue.

Harmony Gold Mining has completed the installation of an automatic winder at No. 2 Shaft and of the first of four 450,000-c.f.m. exhaust fans at the ventilation shaft in the extreme south-eastern section of the lease area. In the No. 2 Shaft area development largely continues to be off-reef preparatory to the formation of long-wall stopes. This off-reef development is not immediately reflected in the ore reserves.

St. Helena Gold Mines has finished sinking its No. 7 Shaft in the east-central section to a depth of 5,338 ft. The increased ventilation capacity now available to the operations in the No. 2 Shaft area and to the initial development of the upcast reef zone east of No. 7 will facilitate accelerated operations in the near future.

The Rio Tinto Company, which has acquired the Emko Mining and Trading Co., Ltd., is to exploit the latter's copper rights in the Windhoek-Okahandja-Onganga area. Initial plans, it is understood,

Table 1

	1959		1958	
	Short tons	*Value, £*	*Short tons*	*Value, £*
Chrysotile asbestos	24,806·75	2,085,353	25,260·87	2,130,952
Metallic tin	5·7	4,000	17·11	11,260
Anthracite	1,593·82	3,294	—	—
Barytes	460·75	3,975	479·14	3,715
Diaspore	427·84	2,035	940·39	4,493
Pyrophyllite	1,008	1,881	156·24	555
Beryl	2·6	310	—	—
		£2,100,848		£2,150,975

aim at mining and exporting copper ore. It is not yet known whether the company will produce concentrates for refining in the custom refinery of the Tsumeb Corporation.

Swaziland Protectorate.—Mineral production during 1959 was valued at £2,100,848, of which £2,085,353 represents the asbestos output. Anthracite included in the figures after about 59 years is attributed to exploratory development at the Johannesburg Consolidated Investment Co., Ltd.'s anthracite prospect (Table 1). A decline in diaspore was attributed to reduced West German demand, but an initial trial shipment to Japan was effected, while increased sales of associated pyrophyllite were made to South Africa, mainly as a filtering medium. The beryl output resulted from village industry from a scattered and sporadic occurrence near Sinceni, disclosed through prospecting for radioactive mineral.

Prospecting and development was expected to result in the resumption of gold production from one mine in 1960. Indeed in 1959 the efforts of the Geological Survey and Mines Department of the territory were largely concentrated on examining, opening up, and re-sampling various dormant gold mines and gold prospects. Further work was also advanced at the barytes mine and the long-known fluorspar deposits, as well as the beryl deposit mentioned. The Anglo American Corporation subsidiary, Swaziland Iron Ore Development Co., Ltd., intensified its prospecting operations at the Bomvu Ridge iron-ore deposit in a programme that included adit-driving to test at depth accompanied by drilling, pitting, and trenching. Prospecting was extended to an adjacent siderite deposit. Central Mining Finance, Ltd., completed coal exploration in two concession areas. Plans were formulated to investigate a large kaolin deposit in the Mankaiana district.

Trade Notes

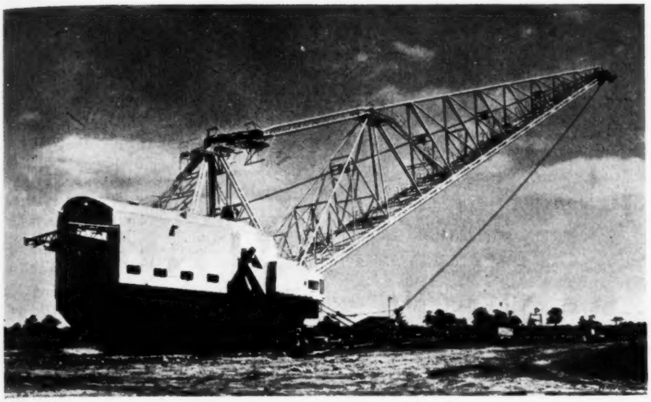
Brief descriptions of developments of interest to the mining engineer

Walking Dragline for Ironstone

Some particulars were released last month of a 1,750-ton dragline, probably, it is suggested, the largest in the world, "walking" over two yards a minute on its two 57-ton feet (which are 48 ft. long and 9 ft. broad), installed by Stewarts and Lloyds Minerals, Ltd., at their Cowthick ironstone quarry near Corby, Northants., for overburden removal. The 303 ft. jib, designed and built by **Tubewrights, Ltd.,** in co-operation with **Ransomes and Rapier, Ltd.,** is constructed of tubular steel and welded throughout for lightness and strength and in its working position the jib head is 185 ft. above the ground. It has a dumping radius of 280 ft., the 22-cu. yd. bucket digging approximately 33 tons a fill. The machine's cycle of filling the bucket, swinging to the discharging point, and returning to the digging position is 56 sec. Manufacture of the machine began early in 1957. The dragline has a slightly larger boom than the company's other walking dragline in the Corby field; this, also of all-British construction, was brought into operation in 1951.

Direct Reduction of Iron Ore

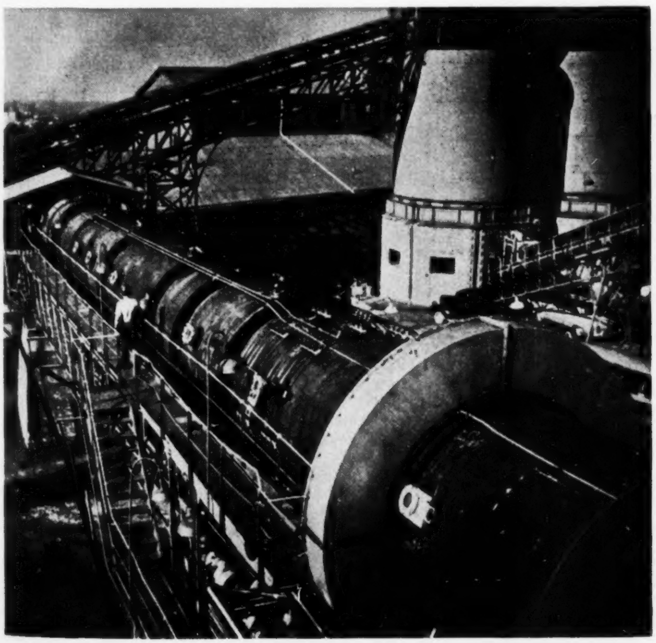
A recent announcement by **Head, Wrightson and Co., Ltd.,** of 20 Buckingham Gate, London, S.W. 1, states that under an arrangement with the R-N Corporation of New York, they are now able to engineer and supply throughout the world complete plants using the R-N process for the direct reduction of iron ore and the production of briquettes of



Walking Dragline for Ironstone Mining.

a very high iron content. The layout, design, and supply of these plants will be undertaken by Head Wrightson Minerals Engineering, Ltd., of Sheffield, and a considerable proportion of the equipment will be manufactured in the works of the company's subsidiaries on Tees-side.

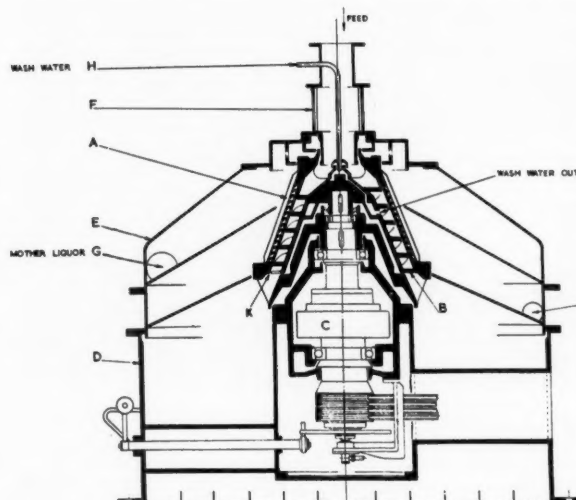
The R-N process, so called from the initials of the two companies which have combined to develop it—Republic Steel Corporation and National Lead Co.—is able to deal effectively with a wide variety of iron ores and is essentially a very simple process. Iron ore is reduced by being heated with a suitable form of solid carbon in a rotary kiln under carefully controlled conditions and a high-grade iron is subsequently extracted from the kiln product and finally delivered as briquettes of convenient size and properties for use in a variety of steel-making processes. Under such conditions the capital and running costs of R-N plants are competitive with other direct reduction processes. In certain conditions, particularly where the



Rotary Kiln at the R-N Plant in Alabama.

Dynoscreen.

A Revolving perforated cone.
B Helical screw conveyor.
C Gear unit.
D Mild-steel base.
E Stainless-steel or mild-steel hood.
F Sight glass.
G Effluent outlet.
H Wash water inlet.
J Wash liquor outlet.
K Screen mesh.



demand for pig iron is small, the process may be competitive with a blast-furnace plant. The product may be fed directly into electric furnaces or open-hearth furnaces.

The Dynoscreen Centrifuge

The recently-introduced Dynoscreen continuous screen type centrifuge is a compact unit of established design for the separation of solids from magmas and slurries and has many applications in the chemical and mining industries, where its design meets modern screening requirements effectively and economically. It can function either as a centrifuge or as a centrifugal screen. Fibrous and granular solids as well as powdery materials possessing free draining characteristics are easily separated and it is not essential for the specific gravity of the solids to be greater than that of the liquor in which they are suspended. When used to separate crystals from magma the Dynoscreen will deliver a product of uniform dryness into a dryer at a continuous rate. Another application is the removal of the liquor occluded by plastics during polymerization.

The Dynoscreen has the capacity and operating efficiency to satisfy the demands of many different industries. Low power requirements, simplicity of operation, ease of installation and maintenance, and its reliability are all features that recommend it for use wherever high-duty performances are needed at minimum cost. These notes are supplied by **International Combustion (Products), Ltd.,** of 19, Woburn Place, London, W.C. 1, by which company the machine is marketed.

Personal

R. D. F. Barry has left for Malaya.

M. A. Bo has left for Burma.

C. W. F. Bond has left for Ghana.

M. Guy Callow has joined Israel Mining Industries as Metallurgical and Project Engineer, with headquarters at P.O. Box 7050, Hakirya, Tel-Aviv.

A. W. Clark is here on leave from Liberia.

W. A. Clements is home from Canada.

J. Damen has left Ghana for the Netherlands.

A. F. Dickson is home from Turkey.

C. B. Forgan has been appointed a director of Selection Trust, Ltd.

K. W. Harrison is now in Northern Rhodesia.

A. Karlstrom has been appointed managing director of the Liberian American–Swedish Minerals Company in succession to Dr. S. Linner, now head of the U.N. Economic and Administrative Commission to the Congo.

G. F. Oats is returning from Northern Rhodesia.

J. Ivan Spens intends to retire from the board of the London Tin Corporation next year. A resolution is to be submitted in due course to shareholders which would provide for the appointment of a President of the Corporation. Subject to the passing of the resolution it is the intention to appoint Mr. Spens as first President of the Corporation on his retirement.

F. H. Way is home from Malaya.

N. W. Wilson has left for Sierra Leone.

The first Annual Dinner of British Columbia Members of the Institution of Mining and Metallurgy was held at the University Club of Vancouver on May 4. In attendance were: J. P. DAVIES, of Vananda; R. B. STOKES, of Merritt; J. D. AUSTIN, W. E. JEFFREY and A. N. LUCIE-SMITH, of Victoria; and F. A. FORWARD, E. B. PAPENFUS, A. C. SKERL, H. V. WARREN, and H. M. WRIGHT, of Vancouver. Regrets were read from the Hon. C. A. BANKS, of Vancouver; B. BUCKLEY and E. N. DOYLE, of Salmo; and J. R. GIEGERICH, of Kimberley.

PHILIP RABONE, who died on July 10, aged 70, was at the Royal School of Mines from 1908 to 1912, taking his Associateship in Metallurgy. In the year last named he went to South Africa, in 1914 joining the Forces in Rhodesia and serving in East Africa. He returned to Europe in 1917 and until the end of hostilities was in France with the Royal Engineers. In 1919, following demobilization, Mr. Rabore joined Minerals Separation, Ltd., and spent the next 15 years in the practice of mineral dressing in various parts of the world concentrating mainly on froth flotation. In 1935 he joined the General Electric Co., Ltd., to take charge of the ore-dressing laboratory at Wembley, but left in 1947 on being appointed to the Government Metallurgical Laboratory in Johannesburg where he was engaged in the development of a method for processing uranium. Ten years later he rejoined G.E.C. Engineering Group, to take the responsibility for all the company's technical literature relating to the mining field. Mr. Rabone was a Member of the Institution of Mining and Metallurgy, serving on the Council in 1946–7 and held the Diploma of the Imperial College, which elected him Fellow in 1958. He was the author of *Flotation Plant Practice*, a widely-acclaimed book which reached its fourth edition in 1957 and is published by Mining Publications, Ltd.

THE INSTITUTION OF MINING AND METALLURGY

Elections and Transfers

Member.—Arthur Paul BEAVAN, B.Sc. (*Montreal*); Robert Springett MACKILLIGIN, C.M.G., O.B.E., M.C. (*London*); Arthur Mathieson QUENNELL, A.O.S.M., B.Sc. (*Dodoma*); Alan John SELF, A.R.S.M., B.Sc. (*Avonmouth*); Samuel Duncan WILLIAMS, B.Eng. (*London*); John Anthony David WINGFIELD (*Heidelberg, Transvaal*).

Associate Member to Member.—John Raymond FLETCHER, B.Sc. (*Kuala Lumpur*); Noel PLINT, B.Sc. (*Witbank*); Cyril George STEVENS, A.C.S.M. (*Shabani*).

Associate Member.—David BLEAKLEY (*Georgetown, B.G.*); Raymond Thomas CANNON, B.Sc. (*Georgetown, B.G.*); William Frederick GARWOOD, A.R.S.M., B.Sc. (*Banket, S. Rhodesia*); Brian Trevor HOSKING, A.C.S.M. (*Lebanon, Transvaal*); Geoffrey David LILL, Ph.D. (*Rotherham*); Patrick James Lindesay LYONS, A.C.S.M. (*Mpanda*); Donald William SMELLIE (*Carp, Ontario*); Ernest Eric WHITE, M.Sc. (*Ilford*).

Student or Affiliate to Associate Member.—Malcolm ALEXANDER, A.R.S.M., B.Sc. (*Dongri Buzurg, India*); John Kenneth ALMOND, A.R.S.M., Ph.D. (*Bromley*); Nigel Edward FORWARD, B.Sc. (*Johannesburg*); Rajnikant Kacharsing GANDHI, A.C.S.M. (*Singbhum*); Kenneth William HARRISON, A.C.S.M. (*Mpanda*); Ian Hartley KEITH, B.Sc. (*Ciudad Truyillo, Dominican Republic*); Arthur Desmond SMALL, A.R.S.M., B.Sc. (*Rangoon*).

Affiliate.—Henri Edmond CROFT (*Barakin Lodi*); Charles Porter SIMPSON (*Jos*); George Cornelius YOUNG-WILLIAMS (*Camborne*).

Student.—John Brindley ALLCOCK (*Isleworth*); John Anthony APPS (*Luton*); Chan Wan CHOON (*Perak*); Chin Tat LOY (*Camborne*); Nigel CLARINGBULL (*Newquay*); Roy COX (*Letchworth*); John Edwin DUNLOP (*Camborne*); Robert William FRAZER (*Johannesburg*); David GOUGH, B.Sc. (*Cardiff*); Christopher HAYCOCKS (*Camborne*); William John HOGG, M.Eng. (*Mufulira*); Michael John HORSLEY (*Dewsbury*); Ellis Newton HUGHES (*Camborne*); Roger Merrett Forrest HULL (*Johannesburg*); Gordon Samuel KEAT (*Port Isaac*); Lau Lin FATT (*Cambourne*); Michael Gordon LEGG (*Salisbury*); David Michael MACGILLIVRAY (*Camborne*); James Nevill MAYOR (*Preston*); Anthony Michael Charles Gordon MOON (*London*); Pierre Francis Xavier MOUSSET-JONES (*Croydon*); Robin Arthur John Teasdale ORAN (*Camborne*); Joseph Michael PRYOR (*Camborne*); Mahmood-ul-Hasan RANA, B.Sc. (*Hindubagh, Pakistan*); James Bowman ROWAN (*Springs, Transvaal*); Maurice George Felix de ST. JORRE, B.Sc. (*Newcastle-under-Lyme*); John Francis TOMAN, A.C.S.M. (*St. Ives*); Ashley WALKER (*Camborne*); Michale John WORRALL (*Johannesburg*); Don Oswald ZIMMERMAN, B.Sc. (*London*).

Metal Markets

During July[1]

Copper.—Copper has remained a most perplexing market to contemplate in July.[2] This, however, is only the result of the complexity of the factors to which dealers have reacted during the month. Undoubtedly the most significant of these is the African situation, particularly the situation in the Congo. It is true that spokesmen for the Union Minière du Haut Katanga have issued an assurance that, after the precipitate flight of European personnel in the face of violent outbreaks, matters are returning much more to normal and that in fact production of copper and cobalt at any rate are almost back to normal. Nevertheless it would be very rash to take a complacent view of the situation in Africa, especially in view of the latest indications that parts of the Central African Federation have not been immune from native disturbances. In the same context mention should be made of the market's very grave fears about the possibility of a strike breaking out at the big Chuquicamata mine in Chile in September, when the present wage contract expires.

Factors like this and the basically healthy rate of actual consumption in Europe up to the onset of the holiday season (which this year has tended to be fairly marked in many metal-consuming industries)

[1] Recent prices, pp. 72, 112.
[2] See Table, p. 112.

have helped to keep prices a good £10 per ton above the level at which they would otherwise have ruled ; some pessimists even say £20.

However, there is no denying that, in spite of the good rate of consumption in Europe, the statistical position grows a little weaker each month as the vast world productive capacity continues to pour out more copper each day than is actually consumed. The fact that this has not had a greater influence on the market sooner is indeed one of the features of copper in the first half of this year, although, of course, it is adequately explained by the factors already enumerated. As far as the London market is concerned certain local factors have tended to keep any runaway rise in prices in check. One of these is that some relief is at last being felt on stocks, the level of which has risen in July, although they are still well below a comfortable level. Another is that the U.S. authorities are now prepared to license U.S. copper for export for delivery on the London Metal Exchange ; previously an actual consumer needed to be named. At present there is a useful amount of copper available there to meet any tightness that might arise in Europe from an African or Chilean shortfall, but the price, delivered this side, is not quite competitive.

U.K. May copper use was 63,659 tons (of which 46,406 tons was refined copper). Production of primary refined metal was 11,053 tons and of secondary refined metal 8,262 tons. Stocks of refined copper jumped to 63,832 tons, but blister stocks were fractionally down at 13,976 tons.

Tin.—Tin has been more interesting from day to day in July than for many months past. Partly as a result of the broad world statistical position, partly as a result of a change in the disposition of Indonesian concentrates, and partly as a result of technical operations on the London market, prices have improved considerably,[1] to the point where it is almost felt to be merely a matter of time before they pass from the middle to the upper range laid down in the Agreement by exceeding £830 per ton.

The Indonesian matter is that Indonesia has decided that her concentrates are better smelted in Malaya, which is nearby, rather than in the U.S.A. or Holland (the latter of course for political reasons). This has meant that U.S. consumers who had been getting material locally from the Texas City tin smelter have now reverted to buying in the East. Meanwhile, however, the Indonesian-Malayan pipeline has been slow to fill and there has been something of a squeeze in Malayan tin ; delivery delays have certainly increased somewhat.

On the London market the bulk of the metal in warehouse stocks is held by the Buffer Stock manager. For day to day trading therefore stocks have been small and the Buffer Stock has lent cash metal to the market. This is now falling due to be repaid ; however, the Buffer Stock cannot lend any more, following expiry of the manager's authority to operate in the middle range. At March 31 the stock held 10,030 tons.

U.K. May consumption was 1,902 tons and production 2,429 tons. Stocks were almost unchanged.

Lead.—This has been another month of dreariness on the lead market, with prices [1] held fairly well down at the £70–£72 level. Basically the situation offers little prospect of change. The growing conviction that those producers restricting their sales to the market will continue to do so after September only means that prices will probably

[1] See Table, p. 112.

be prevented from falling ; not that they will rise. Fortunately moves to boost U.S. import duties seem to have missed the legislative boat. Actual European consumption has been quite good (up to the holiday period), but with batteries a mainstay, more cautious reports from the motor industry are worrying.

U.K. lead consumption in May was 33,459 tons and production of English refined lead was 8,746 tons. During the month stocks dropped sharply to 37,866 tons from 50,363 tons.

Zinc.—Like lead zinc has remained on a basically even keel in July and this has been reflected in the narrow limits within which prices have moved.[1] While there has been some anxiety expressed about future zinc and zinc concentrates supplies from the Congo (not without justification), the overall world metal supply position gives no cause for alarm. The possibility that a greater proportion of world concentrates supplies may be treated nearer the point of arising, or attracted away from Europe, is, however, concerning some of the smelters here.

U.K. May consumption of zinc was 30,848 tons. Production was a mere 4,652 tons and stocks were slightly off at 52,470 tons.

Iron and Steel.—The holiday season is under way and many of the steelworks are closed or have slowed down operations. During this period engineers and maintenance men are busy overhauling plant and equipment, getting it ready for high capacity operations during the final part of the year.

Before production was interrupted for the annual holidays the U.K. steel industry was working more or less at capacity. In June raw steel output was at the weekly rate of 466,400 tons a week (465,000 tons a week seasonally corrected, the highest this year) and in the first half of 1960 the industry produced 12,390,000 tons, which, stated the Iron and Steel Board, was in line with the estimated total for the year of 24,300,000 tons.

In spite of a substantial increase in home output the demand for sheets continues at such a pitch as to make it necessary to rely on large tonnages of foreign material. In June imports reached the staggering figure of 96,350 tons, which raised the amount brought in during the first half of the year to 351,536 tons, as compared with 98,520 tons in the first half of 1959.

The main strength of the sheet market rests on the prosperity of the motor trade which has been a prodigious consumer these past three years or so. So far the Government's credit restrictions have not had much impact on the consumer goods' industries, but any major drop in motor-car production would of course transform the sheet picture almost over night.

The level of demand for most other steel products remains impressive and delivery dates are tending to lengthen. In addition to sheet consumers other users have been importing foreign iron and steel and total arrivals in June, at over 200,000 tons, were the highest since April, 1956. British exports continue at a high level and amounted to just over 1,750,000 tons in the first half of 1960, but have shown a general tendency to decline.

Iron Ore.—The clamant needs of the smelting shops for blast-furnace metal have boosted the requirements of iron ore. Imports have been stepped up to record levels and in the first half of the year they reached 8,458,137 tons, an increase of nearly

[1] See Table, p. 112.

3,000,000 tons over the first half of last year. Supplies from most overseas sources showed a substantial rise and the U.K.'s leading foreign supplier, Sweden, shipped over 2,300,000 tons. Imports from Algeria reached 1,065,724 tons, Canada, 891,463 tons, and Venezuela, 829,120 tons. Domestic ore production remains at a high level and averaged 337,200 tons a week in May.

Aluminium.—The one event of any real importance to the United Kingdom aluminium industry in July was the publication by the Board of Trade of import figures for the first half of the year. The outstanding thing about them was that a new record was established, not only for first-half imports, but also for any single half-year period. Total arrivals in the six months ended June 30 amounted to 185,866 tons, as compared with 123,170 tons in the corresponding six months of 1959. By far the biggest proportion—nearly half—came from Canada. Total arrivals from that source amounted to 91,066 tons, an increase of nearly 20,000 tons over the 71,346 tons imported from that country in the first half of last year. Arrivals from the United States (63,238 tons) increased by over 41,000 tons on the corresponding period last year. On the other hand arrivals from European sources showed something of a decrease overall. While arrivals of Norwegian metal increased, arrivals from France were almost negligible and imports of Russian metal were well down at 2,076 tons as compared with 7,030 tons in the first half of 1959.

The increase in arrivals from Canada is worthy of note in view of the fact that United States penetration into the aluminium industry in this country in the last two years—and particularly in the last year—has inevitably meant some loss of outlets for Aluminium, Ltd., the main Canadian producer. At the same time, however, it must be borne in mind that nearly one-sixth of the indicated total Canadian arrivals this year, on the basis of the present annual rate of 180,000 tons, is likely to be accounted for by imports of casting alloys and hardeners, which are produced in Canada from virgin metal. Nor must it be forgotten that British Aluminium's primary metal supplies are all derived from the Canadian British Aluminium organization —virtually none coming from Reynolds Metals in the U.S.A.

Antimony.—While there has not been any change in the market for English regulus in the last few weeks—prices for 99·6% and 99% are still quoted at £197 10s. and £190 respectively—the market for imported Chinese metal has become somewhat firmer and c.i.f. prices have been advanced under the stimulus of brisk business at home and overseas. Per metric ton c.i.f. 99% Chinese regulus is now quoted at £135 to £138, while 99·6% material is fetching £141 to £144.

The ore market continues healthy and prices are still the same as those established in March, when keen Japanese inquiry caused a general stiffening of the market—namely, 19s. to 20s. per unit of metal contained for 50% to 55% ore and 20s. to 21s. for 60%. Towards the end of July there were rumours of further firming up of the market as a result of continued Japanese interest, backed up this time with rather more Continental attention. It was even reported that some consumers had paid "particularly high" prices for 60% ore, but observers in this country said subsequently that such a claim was without foundation.

Arsenic.—The market for arsenic again showed no new features of note in July and quotations were once more unchanged at £400 a ton for the metal and £40 to £45 a ton for the trioxide.

Bismuth.—Bismuth showed no new features from the market point of view during July and the quoted price for the metal was (and still is) again unchanged at a nominal 16s. a lb. for one-ton lots ex-warehouse.

Cobalt.—Since the outbreak of the present troubles in the Congo at the beginning of July some consumers have been expressing fears over future world supplies of cobalt. It has been suggested however, that such fears are practically groundless in view of the additions to world reserves that have made their appearance in recent years. Present price movements (or, rather, the lack of them) would seem to indicate that this is the majority view. Quotations for open-market metal in the United Kingdom in July were again unaltered at 12s. a lb. delivered, while contract material remained priced at 10s. 9d. a lb. delivered. On the other hand any complete stoppage of Congo supplies (an unlikely eventuality) would undoubtedly mean something of a shortage, considering the Congo accounts for over half the tonnage produced in the world at present. It is felt, however, that any such shortage would be only temporary. Any reduction in supplies from the area would almost certainly have some effect on prices in the short term, if only acting to arrest the downward drift of recent times.

Cadmium.—Cadmium prices have again been unchanged in July so far as the United Kingdom was concerned. U.K. and Empire refined metal continued to sell at 10s. 6d. a lb. and foreign metal was quoted throughout at 10s. 6d. to 10s. 9d. The total United Kingdom consumption of cadmium in the first five months of the year showed an improvement of 68 tons over that for the same period last year, according to figures released in July by the British Bureau of Non-Ferrous Metal Statistics. It has been pointed out, however, with an eye to the rest of this year, that these figures reflect the generally increased rate of industrial activity in early 1960 and since the cadmium consuming industries include the motor industry (cadmium colours and plating) and the radio industry (cadmium-plated components), both of which are particularly vulnerable to the latest credit squeeze influences, such a rate may well be cut in the coming months.

Chromium.—The chromium metal market showed no new features in July and quotations for this country were unaltered at 6s 11d. to 7s. 4d. a lb.

Tantalum.—Tantalum ore continued to sell throughout July at 700s. to 750s. a unit.

Platinum.—There was no change in the platinum market. U.K. and Empire material was priced throughout at £30 5s. per troy oz., while open-market metal was again quoted at £28 5s. to £28 15s.

Iridium.—Iridium sponge and powder was again quoted at £22 to £26 15s. a troy oz.

Palladium.—Palladium remained quoted at £8 10s. to £9 7s. 6d. per troy oz.

Osmium.—Osmium showed no new market features in July and the price remained at £20 to £25 per troy oz.

Tellurium.—The tellurium market remained much the same in July as in June with prices for tellurium lump and powder and tellurium sticks once again 25s. a lb. and 40s. a lb., respectively, values which were established in May.

Tungsten.—Some reasonable tonnages of tungsten ore changed hands in the middle part of July after a quiet start, but by and large the month was quiet from a trading point of view with only a scattered number of deals at prices within the range 156s. to 162s. per long ton unit, which was established in the first week. In the latter half of the month there were reports that the trade was actively considering the possibility of a barter with the United States over a two-year period. If it comes off it is thought that about 1,000 tons of ore will be involved.

Nickel.—It was reported mid-way through the month that the recent negotiations between officials of the United States General Services Administration and a Cuban delegation over the future of the Nicaro plant in Cuba, referred to last month, would be resumed in August. At the same time it was reported that while the Cuban Government has not yet given customs clearance for the plant's normal monthly nickel shipments to the United States—such a clearance was first refused in April—Nicaro is still operating and shipping metal on a spot basis, under a special authorization.

The other big news of the month with regard to nickel was a report that final agreement has at last been reached between the German and Greek interests involved in the plans to resume operations at Larymna. The improved installations to be set up there are expected to be in operation in about two years' time. Planned output from the area includes about 4,000 tons annually of " nearly pure " nickel.

Refined nickel is still quoted at £600 a ton for lots of one ton and over.

Chrome Ore.—The chrome-ore market showed few features of note during July with the exception of news of negotiations between Japanese and Southern Rhodesian interests for 2,000 tons of Rhodesian lumpy chrome ore and 4,000 tons of concentrates. The import price of the chrome ore was understood to be \$30·10 per long ton f.o.b. basis for 48% material and that of the concentrates between \$26 and \$27 per ton. Rhodesian metallurgical ore is again quoted at £15 5s. a ton c.i.f., while Turkish metallurgical remains listed at a nominal \$33·5 a ton f.o.b.

Molybdenite.—A threat of a strike at the Climax, Colorado, mine of American Metal Climax which blew up towards the end of July over the question of new labour contracts proved short lived when new contracts were signed about a week before the month end. Earlier there had been new fears expressed as to the possibility of a shortage in the coming months following the high rate of offtake in Europe and the United Kingdom so far this year. These have again been discounted by the producers. American Metal Climax material is still priced at 8s. 11d. per lb. of Mo contained so far as this country is concerned. Material from other sources is still quoted at 9s. 3½d. per lb. c.i.f., but this is largely nominal.

Manganese Ore.—There were two items of market interest with regard to manganese ore in July. Turkey reported a revival of interest from various countries, including France and Spain, which were said to have inquired for sizeable quantities, and the conference freight rate from India to Western Europe was cut by 5s. a ton from 72s. 6d. C.i.f. offering prices were indicated 1d. per unit lower at 68d. to 72d. in consequence, but with the gap between buyers and sellers still wide this price remains still very much in the nature of a mere negotiating bracket.

Tin, Copper, Lead, and Zinc Prices

Tin, minimum 99·75% ; Copper, electro ; Lead, minimum 99·75 ; and Zinc, minimum 98% per ton.

Date	Tin		Copper		Lead		Zinc	
	Settlement	3 Months	Spot	3 Months	Spot	3 Months	Spot	3 Months
	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.	£ s.
July 12	808 0	801 10	260 5	251 12½	71 2½	72 5	90 10	90 3¾
13	809 0	802 10	259 5	251 12½	70 17½	71 17½	90 11¼	90 6¼
14	810 0	805 10	257 15	249 15	70 8¾	71 16¼	90 1¼	90 1¼
15	813 0	806 15	252 10	246 0	70 17½	71 17½	90 6¼	90 0
18	811 10	808 10	252 10	246 2½	70 16¼	71 13¾	90 3¾	89 13¾
19	813 10	810 15	255 5	247 7½	71 1¼	71 16¼	90 2½	89 13¾
20	818 10	818 10	257 2½	248 5	71 1¼	71 18¾	90 17½	90 2½
21	823 10	823 5	256 17½	248 15	71 8¾	72 8¾	91 6¼	90 6¼
22	819 0	818 15	249 15	245 15	71 3¾	72 2½	90 17½	89 18¾
25	816 0	816 0	250 5	246 15	70 18¾	71 18¾	90 7½	89 11¼
26	818 10	818 10	251 5	246 12½	71 5	71 18¾	90 6¼	89 13¾
27	818 10	818 5	254 7½	248 7½	71 17½	72 3¾	90 1¼	89 13¾
28	816 0	816 15	252 15	247 5	71 7½	71 12½	89 8¾	89 3¾
29	815 10	815 5	251 17½	246 17½	71 1¼	71 3¾	89 1¼	88 7½
Aug. 1	—	—	—	—	—	—	—	—
2	814 0	814 10	253 5	248 7½	71 7½	71 7½	88 6¼	88 2½
3	814 0	813 15	253 12½	248 7½	71 3¾	71 8¾	89 1¼	88 13¾
4	813 0	813 5	251 15	248 2½	70 18¾	71 10	89 12½	89 2½
5	809 0	810 15	249 17½	247 0	70 12½	71 2½	89 3¾	88 15
8	804 0	805 0	250 7½	247 2½	70 13¾	71 1¼	89 1¼	88 13¾
9	806 10	807 5	250 7½	247 7½	70 2½	70 16¼	88 11¼	88 6¼
10	807 0	807 15	248 17½	246 7½	70 7½	71 1¼	88 18¾	88 11¼

Statistics

TRANSVAAL AND O.F.S. GOLD OUTPUTS

	June		July	
	Treated Tons	Yield Oz.*	Treated Tons	Yield Oz.†
Blyvooruitzicht	133,000	86,483	133,000	86,519
Brakpan	142,000	17,405	146,000	17,539
Buffelsfontein‡	148,000	59,057	148,000	60,273
City Deep	113,000	23,279	119,000	23,391
Cons. Main Reef	61,000	12,570	62,000	12,028
Crown Mines	198,000	34,729	207,000	34,971
Daggafontein	233,000	47,201	233,000	47,217
Dominion Reef	41,600	514	43,500	290
Doornfontein‡	105,000	42,215	105,000	42,620
D'rb'n Roodeport Deep	193,000	35,666	198,000	36,016
East Champ D'Or‡	12,500	356	12,000	330
East Daggafontein	106,000	18,020	106,000	18,026
East Geduld	132,000	38,610	129,000	37,440
East Rand P.M.	223,000	53,377	234,000	53,515
Eastern Transvaal Consol	19,100	6,536	19,100	6,154
Ellaton‡	29,000	6,893	29,000	6,847
Freddies Consol	64,000	13,762	64,000	13,726
Free State Geduld	95,000	82,036	96,000	82,641
Geduld	75,000	12,758	75,000	12,527
Government G.M. Areas‡	52,000	10,838	52,000	10,753
Grootvlei Proprietary	216,000	44,823	219,000	45,443
Harmony Gold Mining	165,000	66,041	167,000	66,830
Hartebeestfontein‡	120,000	55,823	120,000	55,796
Libanon	117,000	27,685	117,000	27,910
Loraine	82,000	17,430	81,000	17,217
Luipaards Vlei‡	120,000	13,234	120,000	13,579
Marievale Consolidated	99,000	24,180	99,000	24,180
Modderfontein East	141,000	13,047	125,000	12,834
New Kleinfontein	77,000	9,886	77,000	9,891
New Klerksdorp‡	12,000	1,090	11,000	1,042
President Brand	118,000	95,600	118,000	95,590
President Steyn	100,000	37,509	100,000	37,311
Rand Leases	190,000	28,310	192,000	28,032
Randfontein‡	177,000	13,369	173,000	13,272
Rietfontein Consolid't'd.	15,500	4,072	15,000	4,060
Robinson Deep	44,000	10,311	43,500	10,155
Rose Deep	23,000	4,320	23,000	4,190
St. Helena Gold Mines	167,000	56,784	167,000	56,782
Simmer and Jack	74,000	13,360	75,000	13,430
S. African Land and Ex.	97,500	20,232	98,500	20,452
S. Roodepoort M.R.	30,000	7,188	30,000	7,213
Spaarwater Gold	11,000	3,417	11,000	3,429
Springs	102,000	14,169	102,000	14,091
Stilfontein Gold Mining‡	167,000	75,450	168,000	75,936
Sub Nigel	65,500	15,239	66,500	15,079
Transvaal G.M. Estates	7,000	1,815	7,300	1,966
Vaal Reefs‡	102,500	46,126	105,000	47,251
Van Dyk Consolidated	75,000	12,025	75,000	11,821
Venterspost Gold	126,000	34,014	123,000	34,133
Village Main Reef	30,000	4,624	32,000	4,720
Virginia O.F.S.‡	136,000	28,586	136,000	28,579
Vlakfontein	52,000	18,692	52,000	18,858
Vogelstruisbult‡	85,000	18,364	85,000	18,330
Welkom Gold Mining	102,000	32,155	102,000	32,148
West Driefontein‡	130,000	120,051	130,000	120,836
West Rand Consol.‡	212,000	21,429	216,000	22,005
Western Holdings	154,000	102,715	157,000	104,436
Western Reefs	146,500	41,459	143,500	40,611
Winkelhaak	90,000	28,800	93,000	30,225
Witwatersrand Nigel	20,000	4,437	20,000	4,430

† 249s. 5d. * 249s. 8d. ‡ Gold and Uranium.

COST AND PROFIT IN THE UNION *

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Sept. 1959	18,214,200	70 5	45 2	25 3	30,140,529
Oct.	—	—	—	—	—
Nov.	—	—	—	—	—
Dec.	17,670,000	72 2	45 10	26 4	30,559,937
Jan., 1960	—	—	—	—	—
Feb.	—	—	—	—	—
Mar.	17,464,400	72 8	46 5	26 3	30,105,571
April	—	—	—	—	—
May	—	—	—	—	—
June	—	—	—	—	31,941,743
July	—	—	—	—	—
August	—	—	—	—	—
Sept.	—	—	—	—	—

* 3 Months.

PRODUCTION OF GOLD IN SOUTH AFRICA

	Rand and O.F.S.	Outside	Total
	Oz.	Oz.	Oz.
July, 1959	1,700,968	48,414	1,749,382
August	1,699,098	36,052	1,735,150
September	1,701,485	36,567	1,738,052
October	1,718,916	33,576	1,752,492
November	1,688,379	34,903	1,723,282
December	1,662,043	31,309	1,693,352
January, 1960	1,701,110	34,651	1,735,761
February	1,675,248	38,859	1,714,107
March	1,664,514	38,744	1,703,258
April	1,734,310	36,720	1,771,030
May	1,765,880	37,897	1,803,777
June	1,775,335	37,530	1,812,865

NATIVES EMPLOYED IN THE SOUTH AFRICAN MINES

	Gold Mines	Coal Mines	Total
October 31, 1959	365,833	32,567	398,400
November 30	358,746	32,067	390,813
December 31	354,058	31,963	386,021
January 31, 1960	372,254	31,993	404,247
February 29	385,027	32,144	417,171
March 31	388,860	30,696	419,556
April 30	385,841	—	—
May 31	383,212	30,933	414,145
June 30	380,593	31,435	412,028

MISCELLANEOUS METAL OUTPUTS

	4-Week Period To July 24		
	Tons Ore	Lead Concs. tons	Zinc Concs. tons
Broken Hill South	32,610	4,830	5,638
Electrolytic Zinc	18,846	921	5,200
Lake George	16,025	1,347	2,410
Mount Isa Mines**	55,926	4,170†	3,000
New Broken Hill	35,640	3,846	7,226
North Broken Hill	46,597	8,775	9,979
Zinc Corp.	42,540	5,656	8,398
Rhodesia Broken Hill*	—	—	—

* 3 Months, ** Copper 3,450 tons blister ; 6,661 tons concs. ; † Metal.

RHODESIAN GOLD OUTPUTS

	June		July	
	Tons	Oz.	Tons	Oz.
Cam and Motor	—	—	—	—
Falcon Mines	20,000	3,919	21,000	4,069
Globe and Phœnix	6,050	2,928	—	—
Motapa Gold Mining	—	—	—	—
Mazoe	3,214	—	3,229	—
Coronation Syndicate	12,002	—	11,936	—
Phœnix Prince*	42,545	3,741	—	—

* 3 Months.

WEST AFRICAN GOLD OUTPUTS

	June		July	
	Tons	Oz.	Tons	Oz.
Amalgamated Banket	54,745	12,904	54,204	12,251
Ariston Gold Mines	41,000	11,866	—	—
Ashanti Goldfields	36,500	29,000	36,500	29,500
Bibiani	32,000	6,750	33,000	6,900
Bremang	—	6,688	—	4,813
Ghana Main Reef	11,466	4,219	10,766	4,230
Konongo	7,226	3,510	7,230	3,375
Lyndhurst	—	—	—	—

PRODUCTION OF GOLD AND SILVER IN RHODESIA

	1959		1960	
	Gold (oz.)	Silver (oz.)	Gold (oz.)	Silver (oz.)
January	46,489	18,077	44,902	29,711
February	43,366	19,806	45,754	29,865
March	48,397	17,394	45,309	29,656
April	46,315	5,694	48,607	6,847
May	46,423	46,280	—	—
June	49,995	31,386	—	—
July	46,512	32,734	—	—
August	38,727	29,178	—	—
September	56,760	33,837	—	—
October	48,528	32,314	—	—
November	47,916	31,092	—	—
December	47,452	31,175	—	—

WESTRALIAN GOLD PRODUCTION

	1958	1959	1960
	Oz.	Oz.	Oz.
January	66,562	63,924	64,794
February	65,965	65,035	66,789
March	65,420	65,408	61,941
April	60,855	62,686	65,373
May	64,196	64,184	66,682
June	67,929	74,590	74,902
July	81,106	78,974	—
August	68,610	—	—
September	68,744	—	—
October	70,128	70,427	—
November	67,562	68,858	—
December	120,106	117,474	—
Total	867,187	861,122	—

AUSTRALIAN GOLD OUTPUTS

	4-Week Period			
	To June 21		To July 19	
	Tons	Oz.	Tons	Oz.
Central Norseman	14,116	7,708	13,670	6,813
Gold Mines of Kalgoorlie	40,773	10,885	41,073	10,657
Gt. Boulder Gold Mines*	—	—	—	—
Gt. Western Consolidated	30,248	5,024	31,325	5,053
Lake View and Star*	224,528	50,871	—	—
North Kalgurli	—	—	—	—
Sons of Gwalia	11,880	3,133	11,624	2,579
Mount Morgan	—	4,627	—	4,502

* 3 Months.

ONTARIO GOLD AND SILVER OUTPUT

	Tons Milled	Gold Oz.	Silver Oz.	Value Canad'n $
February, 1959	727,843	227,981	32,976	7,798,523
March	807,952	223,728	33,045	7,616,425
April	776,583	225,027	32,778	7,712,425
May	791,199	227,924	34,006	7,713,970
June	768,725	213,486	31,692	7,178,823
July	774,749	221,814	32,172	7,498,030
August	683,819	191,598	29,141	6,428,545
September	754,208	213,772	34,139	7,116,556
October	794,030	227,192	34,733	7,558,567
November	770,437	227,176	35,262	7,600,949
December	775,803	221,377	40,807	7,388,654
January, 1960	778,103	226,856	27,617	7,550,068
February	755,569	222,484	35,003	7,446,848
March	804,309	229,457	37,202	7,646,044
April	779,487	218,393	42,997	7,426,262
May	784,391	225,550	32,174	7,765,153

MISCELLANEOUS GOLD AND SILVER OUTPUTS

	June		July	
	Tons	Oz.	Tons	Oz.
Clutha River	—	531	—	646
Lampa (Peru)†	—	50,874	—	41,630
New Guinea Goldfields	4,222	2,767	4,507	1,427
Yukon Consol.	—	$324,000	—	—

† Oz. Silver : Copper, 136 tons ; 108 tons.

AUSTRALIAN BASE-METAL OUTPUTS

Period	Concentrate Production (Long Tons)		
	Zinc	Copper (*a*)	Lead
1959	246,693	89,162	305,163
Provisional			
1959—January	12,946	7,744	14,874
February	23,658	8,493	26,361
March	27,377	9,776	30,402
April	82,992	8,142	23,477
May	—	—	—
June	—	—	—
July	—	—	—
August	—	—	—
September	—	—	—
October	—	—	—
November	—	—	—
December	—	—	—

(*a*) includes Cu content of direct smelting ore.

OUTPUTS OF MALAYAN TIN COMPANIES IN LONG TONS OF CONCENTRATES

	May	June	July
Ampat Tin	68½	60	59¾
Austral Amalgamated	—	—	—
Ayer Hitam	—	703*	—
Batu Selangor	—	—	—
Berjuntai	151	149	218¾
Chenderiang	—	58*	—
Gopeng Consolidated	—	383*	—
Hongkong Tin	—	85*	—
Idris Hydraulic	—	71*	—
Ipoh	—	131*	—
Jelapang Tin	—	—	—
Kampong Lanjut	89	110	123
Kamunting	142	138	139
Kent (F.M.S.)	—	65*	—
Kepong	—	—	—
Killinghall	—	128½*	—
Kinta Kellas	29	18	33
Kinta Tin Mines	—	—	—
Klang River	—	—	—
Kramat	63	44	59
Kuala Kampar	115	164	133
Kuala Lumpur	—	—	—
Kuchai	—	—	—
Lahat Mines	—	—	—
Larut	—	—	10
Lower Perak	105	114	160
Malayan	—	1,129*	—
Malaysiam	—	9½	—
Pacific Tin Consolidated	—	—	—
Pahang Consolidated	—	681*	—
Pengkalen	—	104*	—
Petaling Tin	—	261*	—
Puket	—	—	—
Rahman Hydraulic	—	—	—
Rambutan	—	31*	—
Rantau	53½	61½	65¾
Rawang Concessions	—	—	—
Rawang Tin Fields	—	—	—
Renong	—	—	—
Selayang	—	46*	—
Siamese Tin Syndicate (Malaya)	34	31	35
Southern Kinta	344	337	324
Southern Malayan	—	859½*	—
Southern Tronoh	—	—	—
Sungei Besi	—	372½*	—
Sungei Kinta	—	—	—
Sungei Way	—	367½*	—
Taiping Consolidated	—	—	—
Tambah	—	—	—
Tanjong	—	162*	—
Tekka	—	—	—
Tekka-Taiping	—	—	—
Temoh	—	5½*	—
Tongkah Compound	—	—	—
Tongkah Harbour	148½	202	150
Tronoh	—	978½*	—
Ulu Klang	—	—	—

* 3 Months.

MISCELLANEOUS TIN COMPANIES' OUTPUTS IN LONG TONS OF CONCENTRATES

	June		July	
	Tin	Columbite	Tin	Columbite
Amalgamated Tin Mines	371	45	461	—
Anglo-Burma Tin*	—	—	27	—
Bangrin	30	—	81	—
Beralt	5	163†	4	175
Bisichi	38	35	60	60
Ex-Lands Nigeria	40	—	48	—
Geevor	55	—	—	—
Gold and Base Metal	52	8	—	—
Jantar Nigeria	14	18	21	22
Jos Tin	11½	—	—	—
Kaduna Prospectors	5	—	7½	—
Kaduna Syndicate	14	—	19	—
Katu Tin	35	—	37	—
Keffi Tin	—	—	—	—
London Nigerian Mines	—	—	—	—
Mawchi Mines	—	—	—	—
Naraguta Extended	—	—	—	—
Naraguta Karama	8	—	—	—
Naraguta Tin	—	—	—	—
Renong Consolidated	—	—	—	—
Ribon Valley (Nigeria)	—	—	—	—
Siamese Tin Syndicate	49	—	139	—
South Bukeru	—	—	—	—
South Crofty	66	—	—	—
Tavoy Tin	—	—	—	—
Tin Fields of Nigeria	—	—	—	—
United Tin Areas of Nigeria	14	1	—	—

* 3 Months. † Wolfram.

SOUTH AFRICAN MINERAL OUTPUT

May, 1960.

Gold	1,802,015 oz.
Silver	190,388 oz.
Diamonds	232,243 carats.*
Coal	3,467,918 tons.
Copper	(*a*) — tons in matte and copper-gold concentrates. (*b*) 4,742 tons of 99·25%.
Tin	208 tons concs.
Platinum (concentrates, etc.)	—
Platinum (crude)	—
Asbestos	14,737 tons.
Chrome Ore	69,335 tons.
Manganese Ore	111,377 tons.
Lead Concs.	— tons.

* *April, 1960*

IMPORTS OF ORES, METALS, ETC., INTO UNITED KINGDOM

		May	June
Iron Ore	tons	1,483,345	1,643,648
Manganese Ore	,,	50,139	32,244
Iron and Steel	,,	161,932	204,350
Iron Pyrites	,,	35,259	9,910
Copper Metal	,,	59,090	45,676
Tin Ore	,,	4,541	6,622
Tin Metal	,,	661	25
Lead	,,	13,075	15,490
Zinc Ore and Conc.	,,	15,128	30,004
Zinc	,,	13,018	15,850
Tungsten Ores	,,	417	598
Chrome Ore	,,	30,128	27,084
Bauxite	,,	22,475	21,221
Antimony Ore and Concs.	,,	1,503	1,529
Titanium Ore	,,	40,629	25,607
Nickel Ore	,,	—	—
Tantalite/Columbite	,,	133	21
Sulphur	,,	47,646	32,539
Barytes	,,	2,518	4,865
Asbestos	,,	17,786	15,073
Magnesite	,,	7,606	11,682
Mica	,,	1,361	331
Graphite	,,	580	942
Mineral Phosphates	,,	114,664	93,486
Molybdenum Ore	,,	421	750
Nickel	cwt.	45,706	43,205
Aluminium	,,	167,558	610,354
Mercury	lb.	557,585	168,194
Bismuth	,,	69,330	51,571
Cadmium	,,	314,668	165,763
Cobalt and Cobalt Alloys	,,	261,200	406,196
Selenium	,,	20,423	33,393
Petroleum Motor Spirit.....1,000	gals.	62,390	62,209
Crude	,,	918,139	1,055,150

Prices of Chemicals

The figures given below represent the latest available.

		£	s.	d.
Acetic Acid, Glacial	per ton	106	0	0
,, ,, 80% Technical	,,	97	0	0
Alum, Comml.	,,	25	0	0
Aluminium Sulphate	,,	16	10	0
Ammonia, Anhydrous	per lb.		2	0
Ammonium Carbonate	per ton	59	0	0
,, Chloride, 98%	,,	28	12	6
,, Phosphate (Mono- and Di-)	,,	102	0	0
Antimony Sulphide, golden	per lb.		2	9
Arsenic, White, 99/100%	per ton	47	0	0
Barium Carbonate 98–99%	,,	42	0	0
,, Chloride	,,	45	0	0
Barytes (Bleached)	,,	20	0	0
Benzene	per gal.		5	2
Bleaching Powder, 35% Cl.	per ton	30	7	6
Borax	,,	46	0	0
Boric Acid, Comml.	,,	77	0	0
Calcium Carbide	,,	40	17	9
,, Chloride, solid, 70/75%	,,	13	5	0
Carbolic Acid, crystals	per lb.		1	6
Carbon Bisulphide	per ton	62	10	0
Chromic Acid (ton lots)	per lb.		2	2¼
Citric Acid	per cwt.	9	15	0
Copper Sulphate	per ton	85	0	0
Creosote Oil (f.o.r. in Bulk)	per gal.		1	2
Cresylic Acid, refined	,,		7	0
Hydrochloric Acid 28° Tw.	per carboy		11	6
Hydrofluoric Acid, 59/60%	per lb.		1	1
Iron Sulphate	per ton	3	5	0
Lead, Carbonate, white	,,	116	15	0
,, Nitrate	,,	110	0	0
,, Oxide, Litharge	,,	106	5	0
,, Red	,,	104	5	0
Lime Acetate, brown	,,	40	0	0
Lithopone	,,	57	10	0
Magnesite, Calcined	,,	20	0	0
,, Raw	,,	13	0	0
Magnesium Chloride, ex Wharf	,,	16	0	0
,, Sulphate, Comml.	,,	15	10	0
Methylated Spirit, Industrial, 66 O.P.	per gal.		6	1
Nickel Sulphate	per ton	189	0	0
Nitric Acid, 80° Tw.	,,	32	0	0
Oxalic Acid	,,	132	0	0
Phosphoric Acid (S.G. 1·750)	per lb.		1	4
Potassium Bichromate	,,		1	2¼
,, Bromide	,,	11	2	6
,, Carbonate (hydrated)	per ton	74	10	0
,, Chloride	,,	21	0	0
,, Iodide	per kilo		15	3
,, Amyl Xanthate	,,	Nominal		
,, Hydrate (Caustic) flake	per ton	92	0	0
,, Nitrate	per cwt.	4	1	0
,, Permanganate	per ton	198	0	0
,, Sulphate, 50%	,,	20	13	0
Sal-Ammoniac	,,	70	0	0
Sodium Acetate	,,	63	0	0
,, Arsenate, 58–60%	,,	Nominal		
,, Bicarbonate	,,	18	10	0
,, Bichromate	per lb.		1	0
,, Carbonate (Soda Ash) 58%	,,	16	0	0
,, Chlorate	,,	77	0	0
,, Cyanide	per cwt.	6	18	10
,, Hydrate, 76/77%, solid	per ton	33	0	0
,, Hyposulphite, Comml.	,,	35	0	0
,, Nitrate, Comml.	,,	29	0	0
,, Phosphate (Dibasic)	,,	40	10	0
,, Prussiate	per lb.		1	0¼
,, Silicate	per ton	11	10	0
,, Sulphate (Glauber's Salt)	,,	9	15	0
,, ,, (Salt-Cake)	,,	10	0	0
,, Sulphide, flakes, 60/62%	,,	38	12	6
,, Sulphite, Comml.	,,	27	15	0
Sulphur, American, Rock (Truckload)	,,	13	0	0
,, Ground, Crude	,,	17	10	0
Sulphuric Acid, 168° Tw.	,,	12	0	0
,, ,, free from Arsenic, 140° Tw.	,,	8	10	0
Superphosphate of Lime, 18% P_2O_5	,,	14	18	6
Tin Oxide	,,	Nominal		
Titanium Oxide, Rutile	,,	172	0	0
,, White, 25%	,,	85	0	0
Zinc Chloride	,,	95	0	0
,, Dust, 95/97% (4-ton lots)	,,	136	0	0
,, Oxide	,,	105	0	0
,, Sulphate	,,	32	0	0

Share Quotations

Shares of £1 par value except where otherwise stated.

GOLD AND SILVER:	July 8, 1960 £	s.	d.	Aug 9, 1960 £	s.	d.
SOUTH AFRICA:						
Blinkpoort (5s.)	2	13	9	2	17	6
Blyvooruitzicht (2s. 6d.)	1	4	6	1	5	3
Bracken (10s.)	1	2	6	1	5	6
Brakpan (3d.)		4	0		3	9
Buffelsfontein (10s.)	1	19	9	2	0	6
City Deep		13	6		13	6
Consolidated Main Reef		13	0		13	0
Crown Mines (10s.)	1	1	0	1	1	0
Daggafontein (5s.)		17	3		17	3
Dominion Reefs (5s.)		10	3		10	6
Doornfontein (10s.)	1	8	0	1	8	9
Durban Roodepoort Deep (10s.)	1	5	6	1	4	0
East Champ d'Or (2s. 6d.)		2	0		1	6
East Daggafontein (10s.)		8	0		7	9
East Geduld (4s.)		15	6		14	9
East Rand Ext. (5s.)		18	3		18	0
East Rand Proprietary (10s.)	1	6	6	1	5	3
Freddies Consol.		1	9		1	9
Free State Dev. (5s.)		4	0		4	0
Free State Geduld (5s.)	5	13	9	5	18	3
Free State Saaiplaas (10s.)		10	6		9	9
Geduld	2	9	6	2	5	0
Government Gold Mining Areas (3d.)		2	3		2	9
Grootvlei (5s.)		17	6		16	9
Harmony (5s.)	1	7	3	1	9	3
Hartebeestfontein (10s.)	2	3	6	2	3	0
Libanon (10s.)		12	0		11	9
Loraine (10s.)	1	4	6	1	4	3
Luipaards Vlei (2s.)		7	0		6	6
Marievale (10s.)	1	4	0	1	4	0
Modderfontein B (3d.)		1	9		1	9
Modderfontein East		10	9		12	0
New Kleinfontein		3	3		3	0
New Pioneer (5s.)	1	10	0	1	9	0
New State Areas (15s. 6d.)			9			9
President Brand (5s.)	2	18	0	2	18	3
President Steyn (5s.)	1	0	9	1	1	6
Rand Leases (9s. 3d.)		5	6		6	0
Randfontein		16	0		14	6
Rietfontein (3d.)		3	0		3	0
Robinson Deep (5s. 6d.)		4	3		4	0
Rose Deep (3d.)		6	9		6	9
St. Helena (10s.)	3	3	6	3	4	6
Simmer and Jack (1s. 6d.)		1	0			9
South African Land (3s. 6d.)		11	9		11	9
Springs (3d.)		1	3		1	3
Stilfontein (5s.)	1	10	0	1	10	6
Sub Nigel (3d.)		8	0		8	0
Vaal Reefs (5s.)	1	18	6	2	0	0
Van Dyk (3d.)		2	6		2	6
Venterspost (10s.)		18	9		19	0
Virginia (5s.)		3	3		3	0
Vlakfontein (10s.)		15	6		15	0
Vogelstruisbult (3d.)		4	6		4	6
Welkom (5s.)		13	9		13	9
West Driefontein (10s.)	4	0	0	4	1	0
West Rand Consolidated (10s.)		16	9		16	0
West Witwatersrand Areas (2s. 6d.)	2	10	6	2	13	9
Western Holdings (5s.)	5	12	6	5	18	9
Western Reefs (5s.)	1	5	3	1	4	3
Winkelhaak (10s.)	1	0	0	1	3	9
Witwatersrand Nigel (2s. 6d.)		1	0		1	0
Zandpan (10s.)		13	9		13	0
RHODESIA:						
Cam and Motor (2s. 6d.)		—			—	
Chicago-Gaika (10s.)		16	3		15	0
Coronation (2s. 6d.)		5	0		5	0
Falcon (5s.)		9	0		10	6
Globe and Phœnix (5s.)	1	11	3	1	10	0
Motapa (5s.)		—			—	
GOLD COAST:						
Amalgamated Banket (3s.)			9			9
Ariston Gold (3s. 6d.)		4	0		3	9
Ashanti Goldfields (4s.)		19	3		17	6
Bibiani (4s.)		2	9		2	6
Bremang Gold Dredging (5s.)		3	0		3	0
Ghana Main Reef (5s.)		2	9		2	3
Konongo (2s.)		1	9		1	6
Kwahu (2s.)		5	9		5	6
Offin River (2s. 6d.)		3	9		3	9
Western Selection (5s.)		4	9		4	6
AUSTRALASIA:						
Gold Fields Aust. Dev. (3s.), W.A.		1	6		1	3
Gold Mines of Kalgoorlie (10s.)		7	0		7	3
Great Boulder Propriet'y (2s.), W.A.		11	3		11	0
Lake View and Star (4s.), W.A.	1	5	0	1	6	0
Mount Morgan (10s.), Q.		15	9		15	9
New Guinea Gold (4s. 3d.)		1	9		1	9
North Kalgurli (1912) (2s.), W.A.		9	3		9	9
Sons of Gwalia (10s.), W.A.		2	6		2	3
Western Mining (5s.), W.A.		9	3		10	9

	July 8, 1960 £	s.	d.	Aug 9, 1960 £	s.	d.
MISCELLANEOUS:						
Fresnillo ($1·00)	1	7	6	1	5	0
Kentan Gold Areas	1	6	3	1	4	3
St. John d'el Rey, Brazil	4	12	6	3	16	3
Yukon Consolidated ($1)		4	3		4	3
COPPER:						
Bancroft Mines (5s.), N. Rhodesia		18	3		18	6
Esperanza (2s. 6d.), Cyprus		2	3		1	9
Indian (2s.)		5	6		5	0
MTD (Mangula) (5s.)		8	6		8	0
Messina (5s.), Transvaal	1	0	0		19	3
Mount Lyell (5s.), Tasmania		5	6		5	3
Nchanga Consolidated, N. Rhodesia	3	1	3	2	15	0
Rhokana Corporation, N. Rhodesia	2	10	0	2	6	9
Roan Antelope (5s.), N. Rhodesia		6	3		5	6
Tanganyika Concessions (10s.)	1	11	9	1	9	6
LEAD-ZINC:						
Broken Hill South (1s.), N.S.W.		12	3		11	6
Burma Mines (3s. 6d.)		1	9		1	6
Consol. Zinc Corp. Ord.	4	0	0	3	15	6
Lake George (5s.), N.S.W.		3	9		4	3
Mount Isa, Queensland (5s. Aust.)	2	12	0	2	12	0
New Broken Hill (5s.), N.S.W.	2	9	6	2	12	6
North Broken Hill (10s.), N.S.W.	1	1	9		19	9
Rhodesia Broken Hill (5s.)		8	3		7	9
San Francisco (10s.), Mexico		19	9	1	0	3
TIN:						
Amalgamated Tin (5s.), Nigeria		10	9		10	3
Ampat (4s.), Malaya		12	9		11	9
Ayer Hitam (5s.), Malaya	6	2	6	1	2	0
Beralt (5s.), Portugal	1	12	3	1	12	3
Bisichi (2s. 6d.), Nigeria		6	0		5	9
Ex-Lands (2s.), Nigeria		3	3		3	0
Geevor (5s.), Cornwall	1	3	3	1	2	9
Gold Base Metals (2s. 6d.), Nigeria		2	6		2	0
Hongkong (5s.), Malaya		11	9		10	6
Jantar Nigeria (3s.)		6	3		6	3
Kaduna Syndicate (2s.), Nigeria		3	3		3	0
Kamunting (5s.), Malaya		18	6		15	3
Malayan Tin Dredging (5s.)	1	6	3	1	3	6
Mawchi Mines (4s.), Burma		1	3		1	0
Naraguta Karama (5s.), Nigeria		1	6		1	7½
Pahang (5s.), Malaya		12	0		10	9
Siamese Synd. (5s.)		15	6		12	9
South Crofty (5s.), Cornwall		4	6		4	6
Southern Kinta (5s.), Malaya	1	8	3	1	4	9
Southern Malayan (5s.)	1	0	3		17	6
Southern Tronoh (5s.), Malaya	1	2	6	1	1	6
Sungei Besi (4s.), Malaya	1	10	6	1	7	0
Sungei Kinta, Malaya		16	6		15	0
Tekka (12s. 6d.), Malaya		9	9		9	6
Tronoh (5s.), Malaya	2	2	3	1	17	0
United Tin Areas (2s. 6d.), Nigeria		2	6		2	4½
DIAMONDS:						
Anglo American Investment	12	0	0	11	10	0
Consol African Selection Trust (5s.)	1	3	3	1	2	0
Consolidated of S.W.A. Pref. (10s.)		10	3		10	6
De Beers Deferred (5s.)	7	3	0	7	0	3
FINANCE, ETC.						
African & European (10s.)	3	2	6	3	2	6
Anglo American Corporation (10s.)	7	5	0	7	6	0
Anglo Transvaal 'A' (5s.)	1	18	9	1	17	6
British South Africa (15s.)	3	18	6	3	15	9
British Tin Investment (10s.)	1	10	6	1	10	0
Broken Hill Proprietary	3	7	6	3	12	6
Camp Bird (10s.)		8	3		7	9
Central Mining	3	9	0	3	10	3
Central Provinces Manganese (10s.)	1	10	3	1	6	9
Consolidated Gold Fields	2	18	9	2	18	3
Consolidated Mines Selection (10s.)	1	11	0	1	9	6
Corner House		14	3		14	9
East Rand Consolidated (5s.)		2	0		2	6
Free State Development (5s.)		4	0		4	0
General Exploration O.F.S. (2s. 6d.)		3	6		3	9
General Mining and Finance	4	6	3	4	7	6
Hendersons (4s.)		9	3		9	0
Johannesburg Consolidated	2	7	6	2	8	9
London & Rhod. M. & L. (5s.)		6	0		5	0
London Tin Corporation (4s.)		13	0		12	0
Lydenburg Est. (5s.)		13	3		13	3
Marsman Investments (10s.)		1	9		1	10½
National Mining		2	0		2	0
Rand Mines (5s.)	3	10	6	3	11	6
Rand Selection (5s.)	2	2	6	2	2	3
Rhodesian Anglo American (10s.)	3	4	0	2	19	3
Rhodesian Corporation (5s.)		2	9		2	6
Rhodesian Selection Trust (5s.)		10	6		9	6
Rio Tinto (10s.)	1	11	3	1	10	0
Selection Trust (10s.)	4	8	9	4	6	6
South West Africa Co. (3s. 4d.)		15	0		13	9
Union Corporation (2s. 6d.)	2	9	6	2	10	3
Vereeniging	4	17	6	4	17	6
West Rand Inv. Trust (10s.)	2	5	0	2	4	0

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section abstracts of important articles and papers appearing in technical journals and proceedings of societies are given, together with brief records of other articles and papers; also notices of new books and pamphlets and lists of patents on mining and metallurgical subjects.

Lashing Gear for Cactus Grab

A note in the *South African Mining and Engineering Journal* for July 1 is entitled " New Lashing Gear Increases Cactus Grab Capacity." It is pointed out that a major factor contributing to the increasing rate of shaft sinking in South Africa in the post-war years has been the adoption of mechanical cleaning methods. There have been no essential changes in the basic design of the cactus grabs employed, but important advances have been made in that of the operating gear. A new hydraulic type, designed by staff on the mine and at Anglo-Transvaal head office, is undergoing tests at Hartebeestfontein and will be employed when the sinking of the No. 4 shaft is undertaken on a full-scale basis.

In 1955, as a result of work on the mine and at the head office, a hydraulically-operated unit was evolved. Two of these were constructed and used in the sinking of two shafts, involving 9,000 ft. of sinking, with comparatively little trouble. Basically it consisted of a horizontal boom pivoted in the centre of the bottom deck of the Galloway stage. The 20-cu. ft. capacity cactus grab was suspended from the piston rod of a vertical cylinder, which could be moved radially along the boom.

Although this lashing unit proved superior in a number of ways to those previously employed it had certain marked weaknesses. It was not manoeuvreable; the stage had to be kept within 16 ft. of the bottom of the shaft during lashing operations, which placed difficulties in the way of such tasks as shaft walling that normally is done concurrently with lashing, and maintaining an effective seal on cylinders operating at a hydraulic pressure of 250 lb. per sq. in. was not easy. A further problem was that some important parts of the unit were situated below the bottom deck of the stage, rendering them liable to damage during blasting operations. In addition the size of the cactus grab could not be increased above 20 cu. ft. as the horizontal boom was not supported at the end and large forces had to be taken on the centre pivot.

In consequence of the lessons learned from the use of this unit and the increasing demands of present shaft sinking the question of a new basic design was tackled on the mine and at the head office in Johannesburg, resulting in the new compressed-air-operated unit, for which application for patent has been made. It consists of a vertical base-section column extending from the top of the lowest second deck through the bottom of the lowest deck of the Galloway stage. Below this point is the horizontal boom operating the grab and at the bottom of the vertical cabin is the driver's cabin. All the vertical load is carried on a ball thrust-bearing fixed on the upper deck. Off-centre loading is carried laterally by a simple roller bearing on the bottom deck. This is so designed that the large rollers can be replaced during operation should the need arise. Rotation of the whole unit is accomplished by a 14-h.p. air motor on the main column above the upper deck driving through a sprocket and internal ring gear.

Radial movement of the boom is provided by two cylinders, one of them being a standby, mounted horizontally inside the boom. Should there be a failure in both cylinders a small air-driven winch can be brought into operation.

A cylinder mounted in the vertical column between the upper and lower decks of the stage

Headframe, No. 4 Shaft, Hartebeestfontein.

raises and lowers the grab through the rope suspending it. If this cylinder should fail a lashing winch mounted on the outside of the column using the same rope can be brought into operation. The main purpose of this winch is to vary the distance between the bottom deck and the shaft bottom by paying out or taking in rope, thus not restricting this distance to any particular figure. In consequence lashing can be done from any reasonable distance above the shaft bottom, making the stage available for walling and any other tasks while cleaning is in progress.

New rope can be brought into use by unreeling from the storage drum, which holds 150 ft. of rope, and reeling in on the lashing winch. During normal operations, with the main cylinder in use, the rope terminates at the lashing winch and the storage drums which are the fixed ends.

As a result of the unit being supported by two bearings 15 ft. apart instead of on one centre pivot bearing, as in the original one, it has been possible to increase the grab capacity from 20 cu. ft.—the largest size used in all South African shaft-sinking operations so far—to 30 cu. ft. In line with this 14-ton kibbles will be used during sinking operations at Hartebeestfontein No. 4 shaft, which is four tons more than those used in the industry in the past.

On the basis of tests done so far, using an air pressure of 90 lb. per sq. in., it is expected that a kibble can be loaded in 90 seconds.

The unit is at present in operation on surface adjoining the No 4. shaft bank. The object of this is, first, to train drivers in its use and, secondly, to determine whether any modifications should be made before full-scale sinking starts.

Winding Practice at Lea Hall Colliery

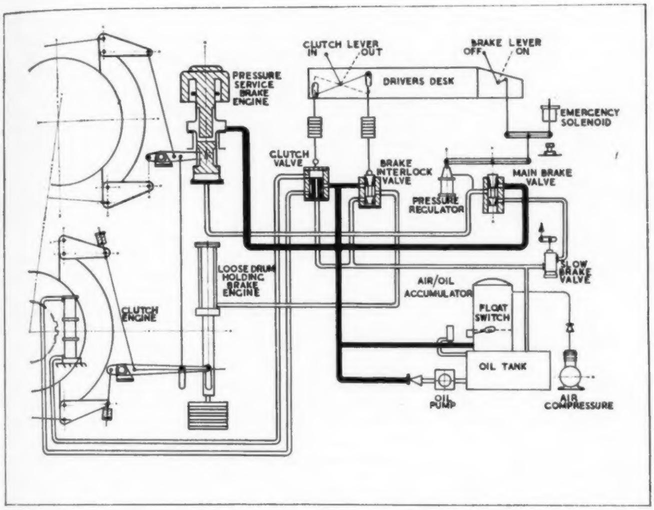
Some notes on the winding engines installed at Lea Hall colliery, officially opened last month, have been supplied by the General Electric Co., Ltd., which supplied much of the equipment for the property. The mine has upcast and downcast shafts, with one winder located at each, although there is provision for two winders at each shaft head. The winder for the upcast shaft is of the double-drum type, to enable winding to be carried out from three levels, and designed for an output of 250 tons per hr. when winding from 1,732 ft. Each drum is 16 ft. in diameter at the rope centres and 3 ft. 6 in. wide between flanges. One drum is fixed to the shaft, the other being driven through an hydraulically-operated multiple-tooth clutch. The clutch teeth are generated over the full circumference of the driving member and give a minimum rope adjustment of 6 in. A system of interlocks ensures that the brake is fully applied to the loose drum before the clutch is withdrawn and conversely that the brake is not released until the clutch is fully engaged.

The drums are arranged for double-layer coiling of the winding ropes and spare rope for recapping is carried on the drum barrel as extra dead coils. Due to the tandem-mounted headsheaves and consequent adverse rope lead, rope risers and kicking plates are provided at the points where the ropes rise from the first to the second layer. The drums are driven by the 2,100-h.p. 375-r.p.m. motor through single-reduction splash-lubricated double-helical gears with a ratio of 9·05 to 1. A loose-dial duplex Lilly controller, type C, gives full protection against overwind and overspeed at any point during the wind. In either contingency the controller causes the emergency brake solenoid to be de-energized, thus applying the brakes.

The brakes for this winder are of the centre-suspended parallel-motion type fitted with woven asbestos friction linings. Operation of the brakes is effected by a low-pressure type brake engine which consists essentially of a two-diameter cylinder fitted with a two-diameter piston, the larger diameter being at the lower end. Any movement of the piston is transmitted to the brake shoes through a system of levers. Constant-pressure oil at approximately 100 lb./sq. in. is supplied to the top of the cylinder and the pressure in the bottom of the cylinder is controlled by the main brake valve and pressure regulator. With the driver's brake lever in the " off " position the oil pressure on both sides of the piston is the same and the piston, because of the larger area at its lower end, is maintained in a raised position, thus holding off the brake shoes. Movement of the lever to the " on " position opens the main brake valve and exhausts the oil from below the piston. The constant pressure on the top of the piston forces it down and so applies the brakes.

The pressure under the piston is governed by a pressure regulator, making it possible to obtain a variation in braking torque from zero to maximum, depending on the position of the brake lever. As indicated earlier, in an emergency the emergency solenoid is de-energized causing the main brake valve to open and exhaust oil from the underside of the brake engine piston, thus applying the brakes. An adjustable stop is provided to control the distance moved by the emergency solenoid and this, in conjunction with the pressure regulator, enables the braking torque applied under emergency conditions to be reduced, if required, from the maximum torque available by movement of the driver's brake lever.

An adjustable relief valve controls the working pressure of the hydraulic system and hence the maximum braking torque can be set to give the required retardation. When winding at high speeds the rate of application of the mechanical brakes is controlled by a slow-brake valve. This restricts the flow of oil from the brake engine at high speeds, but ensures rapid application of the brakes when the winding speed falls. To provide an adequate reserve of pressure oil for operation of the brakes an air/oil accumulator is installed. This has capacity for some twelve or more strokes of the pressure service brake engine and its purpose is to enable the conveyances to be landed safely, under gravity, in the event of a complete power failure. It therefore



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Braking System; Schematic Diagram.

eliminates the likelihood of men being trapped in the shaft, possibly for some considerable time.

The accumulator was specially developed to operate with the pressure-type brake engine. With a normal dead-weight type of accumulator the weight may drop when the brakes are applied rapidly. The inertia effect would then be transmitted to the brake engine and so defeat its purpose, which is to eliminate large moving weights. The brake engine is fitted with a weight system, but this is normally supported by the constant pressure oil. In the event of a sudden failure of pressure, due, for instance, to a broken pipe, the weight falls and applies the brakes.

To change levels the loose-drum conveyance is brought to the pit top and the brakes are applied. The driver then moves the clutch lever to the "out" position. This instantly operates the brake interlock valve, causing oil to flow from the underside of a standard weight-type brake engine which applies the brake associated with the loose drum. Further movement of the lever operates the clutch valve, which allows the oil to flow to the underside of the clutch engine and opens the top to exhaust, thus disengaging the clutch. The new level is then selected, the pressure brake being operated from the driver's brake lever in the normal manner, while the loose-drum conveyance is held at the top of the shaft. When the driver re-engages the clutch, movement of the lever to the "in" position allows oil to flow to the top of the clutch engine and opens the underside to exhaust.

The winding engine at the downcast shaft is of the single-drum type and is capable of an output of 300 t.p.h. from a winding depth of 1,203 ft. The drum is 16 ft. in diameter and 7 ft. wide between the flanges. The winder is designed for single-layer coiling of the winding ropes and has a spirally-grooved drum shell. Most components on this winder, including the main reduction gears, are similar to those of the upcast shaft equipment. The mechanical brakes operate on the same principles, but the hydraulic circuit is simpler because of the absence of clutch equipment.

Electrically the two winders are identical and embody a patented closed-loop speed control system which ensures an adequately close relationship between the steady rope speed and the position of the driver's lever. It also provides for an overriding torque limitation which ensures that excessive torques cannot occur on rapid movement of the control lever. This system is notable for its outstanding performance at the very low speeds required for shaft inspection, rope changing, and similar duties and when lowering heavy loads at slow speeds. For shaft inspection and rope changing the driver has no difficulty in maintaining a steady slow speed throughout the full depth of the shaft.

The system of dynamic braking is such that the heaviest loads can be lowered at creep speed without resorting to mechanical braking. With the mechanical brakes on and the control lever in the position of lowest speed full d.c. excitation can be applied to the motor so that maximum dynamic braking is available immediately the brakes are released and the motor is free to rotate. Thus, as the maximum d.c. excitation is not dependent upon the current flowing in the rotor circuit, there is no undesirable acceleration during the period in which the rotor current is building up.

In the closed-loop system of control fitted to the 2,100-h.p. winders the speed of the winder is determined by comparing in the control circuit the speed of the rope drum with that called for by a pattern potentiometer. Any lack of balance in the control circuit automatically results in an increase in the driving torque or the application of dynamic braking, as may be required to increase or decrease the winder speed until the chosen speed is reached and the state of balance is restored.

Automatic variation of the rotor circuit resistance of the winder motor is effected through the medium of an oil servo-mechanism, the operating valve of which is governed by two control coils acting in opposition to each other. A coil, which causes the resistance in the rotor circuit to be reduced, is energized by alternating current. When driving,

this current varies with the speed error; during dynamic braking it is constant. Another coil, which serves to insert resistance, is excited from the stator or secondary winding of a control generator driven from the winder motor. At any given excitation of the control generator rotor the voltage across this coil reflects that of the rotor of the main winder motor and varies in proportion to the slip or speed. The actual proportion is made dependent upon the speed error.

The driver's lever is arranged to move in a gate in the control desk, the slots for "forward" and "reverse" speed being separated by a small cross gate. The advantage of this feature is that there is a clear distinction between the "off" position, which is in the centre of the cross gate, and the "stop" position at the ends of the cross gate. Thus the driver can pull the lever back from full speed to the "stop" position without over-shooting into the slot for the opposite direction of winding. In the "stop" position a high d.c. excitation is applied to the driving motor with the winder at standstill, thus providing the maximum dynamic braking previously described.

Investigation of Australian Beach-Sand Flowsheets

In report No. 589 of the C.S.I.R.O. Ore-Dressing Investigations, conducted in conjunction with the Mining Department at the University of Melbourne, S. B. Hudson discusses "Classification and Air-Tabling in Beach Sand Flowsheets: Their Influence on the Recovery of Zircon and Rutile, and on the Quartz Content of the Zircon Concentrate." The abstract of this report given here may well be read in conjunction with the description of Australian practice summarized in the MAGAZINE for July.[1]

The author says that a common practice in beach-sand plants is to treat a single-table concentrate for the recovery of the contained rutile and zircon. The quartz content of the table concentrate must be relatively low to enable the production of low-quartz zircon concentrates, but the size ranges of the heavy minerals and of the quartz are such that table concentration will not make a clean separation of quartz from the heavy minerals. In producing a low-quartz table concentrate some rutile and other heavy minerals will be lost in the table tailings. In investigating these losses two series of tests were carried out on each of two beach sand samples. The purpose of the first series was to investigate the mineral losses encountered in the use of certain flow sheets which are, or could be, used in the treatment of heavy mineral concentrates from many of the Australian beach-sand deposits. In the second series of tests several mixtures of zircon and quartz were air tabled to determine the effect of quartz content of the feed on the separability of zircon and quartz.

Many of the beach-sand plants operating along the eastern coast of Australia, the author says, use a relatively simple flowsheet in which a single gravity concentrate is dried and subjected to magnetic and electrostatic separation. In some of the plants the only mineral recovered is rutile and the presence of 10% or even more quartz in the gravity concentrate does not affect the grade of the rutile concentrate, unless the quartz is too coarse to be pinned in high-tension separation. In other plants both rutile and zircon are recovered and if the zircon is to be of first grade, containing, say, 0·1% or less quartz, then the ratio of the weights of quartz and zircon in the gravity concentrate must be not more than 1 to 1,000, as virtually all the quartz will follow the zircon in both magnetic and electrostatic separation.

To meet this rather stringent specification the final gravity concentration is invariably carried out on tables and it is inevitable that a certain amount of heavy mineral will be lost in the table tailings. Rutile, which is economically the most important of the minerals in these sands, has a lower density than has zircon, ilmenite, or monazite, and hence rutile losses will be proportionately higher than zircon, ilmenite, or monazite losses. The losses are brought about solely by the relative sizes of the heavy mineral and quartz grains and not by the presence of composite particles.

Beach-sand deposits may be broadly classed as those which occur on present beaches and those which occur away from present beaches. In the former type of deposit the minerals, including quartz, are reasonably well classified and table concentration of these sands will yield a low-quartz concentrate recovering a high proportion of the rutile and zircon—*e.g.*, table concentrates from two such beach-sand samples contained 98·6% and 96·1% respectively of the rutile in the head samples and yielded zircon concentrates assaying 0·2% and 0·1% quartz, respectively.

In back-dune or inland beach-sand deposits the heavy minerals themselves are reasonably well classified. However, such deposits usually contain wind-blown quartz which may be finer than the heavy minerals; tabling of these sands will not yield a low-quartz table concentrate with a high recovery of rutile and zircon—*e.g.*, table concentrates from two such samples (the head samples of this present investigation) contained only 83·7% and 82·2% respectively of the rutile in the head samples and yielded zircon concentrates assaying 0·4% and 0·9% quartz respectively.

The rutile losses encountered in the treatment of a single table concentrate are therefore much lower when the sands come from present-day beaches than when they come from back-dune or inland deposits and consequently there is little room for improvement of rutile recoveries. However, three of the larger beach-sand plants, including two which are operating on present-day beaches, have adopted two separate and more complex flowsheets to improve rutile recoveries and have apparently found it economic to do so. Replacement of the simple flowsheet in a small plant by one or other of the more complex flowsheets to improve rutile recoveries may not be economic, even if the plant is operating on inland or back-dune deposits. Some of the plants using the simple flowsheet obtain high rutile recoveries, but the zircon concentrates pro-

[1] p. 56.

duced often contain too much quartz to be saleable as high-grade concentrates.

Three flowsheets which do not involve redrying, and hence do not require a second drier, were devised to overcome the problems associated with the three flowsheets already mentioned. In two of them hydraulic classification is used to improve the separation of quartz from heavy mineral and in the third air tabling of a non-conducting, non-magnetic product is used to separate the zircon from the quartz. Classifiers are relatively cheap to install and operate and could be incorporated quite readily into an existing plant; if the plant is of such size that only one wet table is in use it will be necessary to add a second to take one of the classifier products. Air tables could be incorporated fairly readily into an existing plant, but it is possible that in a larger plant wet tabling of a zircon-quartz fraction and redrying of the zircon concentrate would be cheaper than air-tabling of the same fraction. However, this would not be so in a small plant. As far as is known neither of the flowsheets involving classification has been used in Australian beach-sand plants, but at least one company has carried out some tests on the separation of zircon from quartz by means of air tabling.

The purpose of the investigation was to compare the results for the gravity concentration processes involved in the six flowsheets mentioned previously, using as criteria the rutile and zircon losses in the gravity tailings and the quartz contents of the zircon concentrates. The iron and titanium assays of the various rutile and zircon concentrates were not considered, as they are not affected by the gravity concentration. In all calculations it was assumed that magnetic and electrostatic separation of a feed such as a table concentrate yields a conducting, non-magnetic fraction containing only and all of the rutile and a non-conducting, non-magnetic fraction containing only and all of the zircon and quartz—that is, rutile and zircon losses occur in gravity processes but not in magnetic or electrostatic processes. In practice of course this is not so; very frequently losses in magnetic separation alone exceed those in electrostatic separation and gravity concentration. By making these assumptions a considerable amount of grain counting under the microscope was obviated. Sink-float tests on gravity tailings, followed by grain counting of the sink fractions, enabled the rutile and zircon losses to be calculated, since the compositions of the head samples were known from previous work. The quartz contents of the zircon concentrates were obtained directly by means of sink-float tests.

Head Samples

The two head samples used for the investigation were chosen because of the differences in their mineral compositions and in the sizes of the minerals and because they both contained relatively fine quartz One (A) was a secondary spiral concentrate obtained from a pilot dredge and came from a beach-sand deposit near Redhead, which is about 7 miles south of Newcastle, N.S.W. The other (B) was a table concentrate obtained from borehole samples taken from a beach-sand deposit near Harrington, which is about 5 miles east of Taree, N.S.W. The exact locations of the two deposits were not stated, but from the appearance of the samples and because of the presence of fine quartz, it was assumed that the deposits are not on present-day beaches.

For each of the two samples the mineral composition was estimated from the weights and assays, or probable assays, of test products obtained in the course of this present and earlier investigations. These estimates are shown in Table 1, together with the composition of the heavy minerals in the samples.

Table 1

	Sample A		*Sample B*	
	Head % wt.	*Heavy Mineral* % wt.	*Head* % wt.	*Heavy Mineral* % wt.
Rutile	24·2	51·4	25·4	31·4
Zircon	15·5	32·9	38·8	48·0
Monazite	0·4	0·85	0·7	0·85
Ilmenite	5·0	10·6	14·6	18·05
Tourmaline, Garnet, etc.	2·0	4·25	1·3	1·6
Quartz	52·9	—	19·2	—
Total	100·0	100·0	100·0	100·0

Monazite constitutes 0·85% of the heavy minerals in each of the two samples, but in other respects the samples have widely different compositions. Over 70% of the zircon, ilmenite, and rutile in sample A was coarser than 100 mesh, whereas over 75% of those minerals in sample B was finer than 100 mesh. Sample A contained some quartz which is finer than the zircon, while sample B contained some quartz which is finer than 87% of the zircon. Sample A contained some fine, free organic matter, while the mineral particles of Sample B were lightly coated with organic matter. For the flowsheet tests involving magnetic and electrostatic separation the head samples were attrition-cleaned in the laboratory attritioner for a few minutes, using tap water and a water : solids ratio of 2 : 7. Supernatant slimes were decanted, but most of the desliming took place during wet tabling.

Of the six flowsheets tested the first is used in many beach-sand plants and requires only one drier. In keeping down the quartz content of the table concentrate an appreciable amount of heavy mineral is lost in the table tailing. In flowsheet 2 two driers are required and from a plant point of view it is desirable that these should be similar—*i.e.*, the amount of feed to each should be similar. In flowsheet 3 the two driers are of unequal size. All the zircon is dried twice, but the use of air tabling instead of wet tabling, as in flowsheet 6, could obviate the need for the second drier. In flowsheet 4 the table concentrate is virtually quartz-free and the bulk of middling will be large if very fine quartz is present. Classification of the middling yields two products, either or both of which will require retabling. Careful control in primary tabling and classification could possibly result in an overflow containing very little heavy mineral and an underflow containing very little quartz. However, retabling of both products could be regarded as an insurance.

In flowsheet 5 the classification is carried out before tabling—*i.e.*, the whole of the spiral concentrate is classified, instead of part as in the previous flowsheet, while flowsheet 6 is similar to flowsheet 3, the only differences being that the non-conductors are air-tabled instead of wet tabled and that the spiral concentrate is wet tabled to reduce the quartz-zircon ratio in the air-table feed.

In the flowsheets, except the second, the monazite is recovered as a crude concentrate containing

tourmaline and garnet and this crude fraction must be redressed to yield a monazite concentrate.

Air Tabling.—On a wet table the particle size increases and the mineral density decreases, from the top of the concentrate band towards the tailing. On an air table both the particle size and mineral density decrease from the top of the concentrate band towards the tailing—that is, air tabling has much the same effect as hydraulic classification, but wet tabling does not.

In the wet tabling of a raw beach sand the quartz content of the concentrate will increase as the heavy mineral recovery increases ; at the same time the average size of the contained quartz will increase more rapidly than that of the contained zircon. Magnetic and electrostatic separation of a table concentrate will yield a zircon-quartz fraction containing all the zircon and quartz, assuming that there are no losses in the separating processes. Air tabling of the zircon-quartz fraction will yield concentrates whose grade and recovery will depend upon the relative sizes of the zircon and quartz in the air table feed, which in turn will depend upon the amount of quartz that was cut into the original wet table concentrate.

In some of the air-tabling tests described in the report one or more of the middling products contained rather too much quartz to be combined with the air-table concentrate. Such a product could be screened in a plant, after choosing a suitable mesh size, and the oversize discarded. For test work there are two methods by means of which the appropriate mesh size can be chosen. First, to carry out a sizing test on the middling and assay the screen products by means of sink-float tests. Secondly, to carry out sizing tests on the products from the sink-float test on the middling. This second method is the simpler and was used in the air tabling tests where necessary.

Classifiers and Air Tables in Beach-Sand Plants.—Rutile is economically the most important mineral in the east coast beach-sand deposits and hence rutile recovery should be as high as possible, commensurate of course with capital and operating costs. Zircon, on the other hand, is less valuable and in some circumstances the cost of increasing zircon recovery from, say, 80% to 95% may be more than the revenue gained from the additional zircon recovered. It was decided as a result of the investigation that for a plant whose throughput is such that the use of two driers is economic flowsheet 2 or 3 could be used. In flowsheet 2 the proportion of heavy mineral in the upper concentrate could be increased until a tolerable quartz-zircon ratio was attained and the zircon-quartz fraction from the lower table concentrate could be put over air tables instead of wet tables. The air-table feed may contain 5% to 20% of the total zircon, depending upon the relative fineness of the quartz. In flowsheet 3, however, the use of air tables may not be economic because of their relatively low capacity, but classification before wet tabling could increase zircon recovery.

In a smaller beach-sand plant flowsheets 4, 5, or 6 could be used, although the classification of the whole of the spiral concentrate (flowsheet 5) has little to recommend its use. Conversion of an existing flowsheet to flowsheet 4 may require nothing more than a classifier and possibly an extra wet table, because table middlings are commonly circulated already. This conversion will result in increased rutile and zircon recoveries.

The choice of flowsheet depends, it is suggested, to some extent upon the zircon content of the heavy minerals in the sands. If this is low flowsheet 3 is probably preferable to flowsheet 2 and flowsheet 6 to flowsheets 4 or 5.

Conclusions.—In three of the flowsheets tested rutile recovery is independent of zircon recovery and hence it is possible to recover virtually all the rutile and recover low-quartz zircon concentrates at the same time. In two of these flowsheets the zircon-quartz separation is made on a wet table and the fineness of the contained quartz largely determines zircon recovery. In the third of these flowsheets air tabling is used to separate zircon from quartz and it is the coarseness of the quartz which largely determines zircon recovery.

Wet tabling followed by classification of a fairly large table middling and retabling of the classifier products yielded zircon concentrates of lower quartz contents than did classification of a spiral concentrate followed by tabling of the classifier products.

Air tabling tests on a number of zircon-quartz fractions showed that the degree of separation that can be obtained decreases as the quartz content increases and that coarser zircon is more amenable to air tabling than fine zircon. Screening of air-table middlings to increase zircon recovery is very effective with coarse zircon.

Trade Paragraphs

Hadfields, Ltd., of Sheffield, announce that their London office is now at 25, Berkeley Square, W. 1, the telephone number being Hyde Park 0431.

Padley and Venables, Ltd., of Sheffield, announce that their London office is now at Clutha House, 10, Storey's Gate, S.W. 1 (Telephone : Whitehall 0678/9). The company are the proprietors of Rip-Bits, Ltd.

Richard Sutcliffe Ltd., of Horbury, Wakefield announce that Mr. M. R. Moore, who became general sales manager of the company earlier this year, has now been promoted to the position of general manager.

Furnival and Co., Ltd., of Stockport, in a recent notice referring to Andantex reduction units, which were described in the MAGAZINE in October, 1958, state that a separate company has now been formed to undertake their manufacture and sale. The new company is **Andantex, Ltd.,** of Tamworth Street, Higher Openshaw, Manchester and it is directly associated with Société Redex, of Paris.

National Chemical Products, Ltd., of Johannesburg announce that a change has recently been made by the Plastics Group of the Distillers Co., Ltd., of Britain in the South African representation for British Geon, Ltd., whereby that company's acrylonitrile rubbers, latices, etc., are now sold in South Africa by National Chemical Products, Ltd.

C. C. Wakefield and Co., Ltd., of Castrol House, Marylebone Road, London, N.W. 1, state that in future the company is to be known as **Castrol, Limited.** Prior to this announcement Wakefield-Dick Industrial Oils, Ltd., produced a 74-page handbook on hydraulic oils, which is well illustrated and contains a great deal of useful information for those concerned with the operation of hydraulic equipment.

Robert Hudson, Ltd., of Leeds in a recent Press announcement state that among the first ships to reach Canada's Hudson Bay this season is one carrying 300 transport cars manufactured by them for the International Nickel Company of Canada for service at the new refinery at Thompson Lake, Manitoba.

Ferodo, Ltd., of Chapel-en-le-Frith, manufacturers of brake and clutch linings, annouce their intention of building a new factory in Caernarvonshire in order to expand production facilities for friction materials generally. Apart from overseas companies this will be the first time that a Ferodo factory has been established away from Chapel-en-le-Frith since Herbert Frood, the inventor of brake linings as we know them to-day, opened his works there 60 years ago.

Megator Pumps and Compressors, Ltd., of 43, Berkeley Square, London, W. 1, have added a new floating suction strainer, for use with 6-in. hose, to the "Dolphin" range described in the MAGAZINE for March, 1959. The new strainer, the largest in the range, is capable of dealing with water flow at rates of up to 750 gall. per min. and is expected to extend the field of applications considerably.

Sheffield Wire Rope Co., Ltd., of Darnall, Sheffield, in a new revised 70-page catalogue lists the company's ropes in accordance with the revised standards issued by the British Standards Institution together with introductory notes. These cover, in text and illustration, such subjects as the lays of wire rope, preformed wire rope, the handling and care of ropes, and recommended pulley diameters, etc. The company, which celebrated its Golden Jubilee in 1959, produces rope for the mining and engineering industries.

Head Wrightson Minerals Engineering, Ltd., of 46, Rutland Park, Sheffield, in a new well-illustrated booklet describe a variety of coal-preparation plants in which they specialize. Mention is made of the Lee Bar separator and the Stripa process, applications of which extend to other branches of mineral processing. It was stated in the June issue this company's name has recently been changed to indicate the expansion of its activities into the treatment of minerals other than coal. However, the booklet here mentioned is devoted particularly to coal treatment.

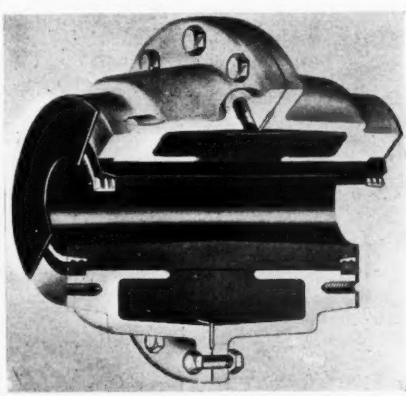
General Electric Co., Ltd., of Erith, Kent, state that a pan feeder recently manufactured at Fraser and Chalmers Engineering Works is believed to be the longest ever built in the United Kingdom. The feeder forms part of a contract placed with the company last year by the Associated Portland Cement Manufacturers, Ltd., for a limestone crushing plant in Western Nigeria, comprising a feed hopper, a variable-speed inclined pan feeder, and a Dixie non-clog hammermill, with the necessary chutes and discharge hoppers, all housed in a suitable building. It is designed to crush rock up to a maximum dimension of 36 in. at the rate of 200 tons per hour.

Allis-Chalmers Manufacturing Co., of Milwaukee, Wisconsin, are to supply a research reactor to the South African Atomic Energy Board, it is announced, under the terms of an agreement reached between representatives of the Board, of the Roberts Construction Co. of South Africa, and Allis-Chalmers Nuclear Power Department, Washington, (D.C.). The reactor, which will be an advanced version of the ORR reactor now operating at the Oak Ridge Laboratory of the U.S. Atomic Energy Commission, will operate initially at a 6,600-kW power level but will be designed for ultimate operation at levels as high as 20,000 kW. The extensive experimental facilities which are a feature of the proposed design will aid a large nuclear research and development programme.

Permutit Co., Ltd., of Gunnersbury Avenue, London, W. 4, draw attention to their portable Deminrolit unit which can convert up to 12 gallons hourly of clean cold water into demineralized water having a conductivity of less than 1·0 reciprocal megohm per centimetre. The unit is a mixed bed ion exchanger, the ion-exchange materials used being "Zeo-Karb 225" and "De-Acidite FF", which are manufactured by the company at their Chemical Production Division in South Wales. It is designed for simple and reliable regeneration on the spot and a conductivity tester is fitted which continuously monitors treated water quality. The Mark 6 portable is an addition to the range of portable "Deminrolit" units. For greater outputs of very pure water Permutit design and manufacture industrial plants for dealing with practically any quantity.

Merton Engineering Co., Ltd., of Faggs Road, Feltham, Middx., in a recent note draw attention to the latest addition to their range of loading shovels—the Merton Sherman "Universal," combining hydraulic Frontloader 59 and the Sherman Panther power digger. The outstanding advantage is the way in which the digger, when not in use, is carried in a folded position, an arrangement made possible by the design of the Frontloader 59 itself. Because the presence of the digger makes virtually no difference to the dimensions or stability of the shovel it need never be dismounted, even when the loading shovel is required for arduous work in confined spaces. The machine can change functions as often as required and it takes only $2\frac{1}{2}$ minutes to lower or raise the digger and be ready for work in either guise.

Neldco Processes, Ltd., of Crossway House, Bracknell, Berks., issue particulars of a new model of the Sala round-aperture valve, which was first mentioned in the MAGAZINE for March, 1958. A new model of this valve, Type C, is now available. As will be seen from the sectioned illustration it has a continuous liner throughout the valve, the closure being controlled by pneumatic or hydraulic pressure exerted on the rubber muscle. The pressure required for operation is about one-third less than with



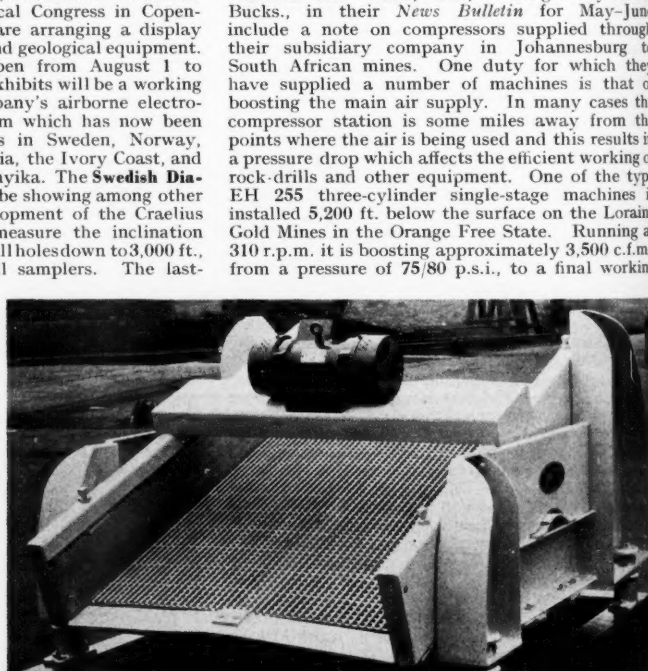
the previous model and the overall size is reduced. The round aperture is infinitely variable from full bore to full closure and the venturi shape of the aperture produces very low pressure loss. Aperture is directly proportional to pressure applied so that the pressure-gauge reading gives an exact indication of the valve opening. It is available in sizes from 1 in. to 4 in.

W. J. Jenkins and Co., Ltd., of Retford, Notts., refer to a new development in high-speed vibratory screen design. On these screens, which are to be known as the Viking-Grantham, the drive and vibrator are incorporated into the motor which renders obsolete the conventional out-of-balance shaft with heavy bearings and "V" rope drive. In addition to simplifying the design there is a considerable saving in the power required and a wide range of adjustment to the amplitude of vibration is easily obtained by a simple operation, giving a maximum in excess of that obtained by other methods. These important advantages together with the adjustable angle of deck from 5° to 30° make these screens suitable for a wide range of materials and duty. Single and double deck models are available in two sizes—4 ft. long by 2 ft. 7 in. wide and a 5 ft. long by 3 ft. 7 in. wide.

AB Elektrisk Malmletning (ABEM), of Danderydsgatan 11, Stockholm, in connexion with the 21st International Geological Congress in Copenhagen from August 15–25 are arranging a display of their latest geophysical and geological equipment. This exhibition will be open from August 1 to September 10. One of the exhibits will be a working model of the ABEM Company's airborne electromagnetic prospecting system which has now been used to carry out surveys in Sweden, Norway, Finland, Canada, Mauretania, the Ivory Coast, and Kenya, Uganda, and Tanganyika. The **Swedish Diamond Rock Drilling Co.** will be showing among other equipment the latest development of the Craelius dip indicator which can measure the inclination and direction of diamond-drill holes down to 3,000 ft., a core orientator, and soil samplers. The last-named company is the parent of the Craelius organization and has associate companies in England, France, Spain, Italy, Germany, Iran and East Africa.

Goodyear Tyre and Rubber Co. (Great Britain), Ltd., of Wolverhampton, in a recent notice introduce their "Wingflex" high-pressure wire-braided hose in bore sizes from $\frac{5}{32}$ in. to 2 in. wth either re-usable or swaged couplings (according to pressures) and in one or two braid constructions. Consisting of a seamless and oil-resistant synthetic rubber tube with a smooth bore, the hose is designed to operate throughout a range of pressures from 600 to 4,000 p.s.i. in the one wire braid construction and from 1,000 to 5,000 p.s.i. in the two wire braid construction. It is reinforced with high-tensile steel wire which is uniformly braided over the lining. The cover is made of synthetic rubber compound (resistant to abrasion, oil, light, and flame) and the complete hose is uniformly vulcanized and concentric throughout its length. Wingflex will be supplied in either 60-ft. lengths uncoupled or in lengths coupled either with re-usable couplings or the swaged-type couplings. Every single assembly is tested individually. Couplings are designed to withstand pressures well in excess of the burst pressure of the hose.

Broom and Wade, Ltd., of High Wycombe, Bucks., in their *News Bulletin* for May–June include a note on compressors supplied through their subsidiary company in Johannesburg to South African mines. One duty for which they have supplied a number of machines is that of boosting the main air supply. In many cases the compressor station is some miles away from the points where the air is being used and this results in a pressure drop which affects the efficient working of rock-drills and other equipment. One of the type EH 255 three-cylinder single-stage machines is installed 5,200 ft. below the surface on the Loraine Gold Mines in the Orange Free State. Running at 310 r.p.m. it is boosting approximately 3,500 c.f.m., from a pressure of 75/80 p.s.i., to a final working



Jenkins Viking-Grantham Screen.

Loading with Libu Shovels at Avoca.

pressure of 105 p.s.i. One of the latest installations for a similar duty is of the type SS1 two-cylinder single-stage double-acting machine. This is installed on the surface and boosts 5,000 c.f.m. through a similar pressure range. Two SS2 two-cylinder single-stage double-acting compressors are installed in the reduction works of Winkelhaak Mines to provide low-pressure air for agitation in cyanide tanks. Each running at 420 r.p.m. delivers 1,225 c.f.m. at 40 p.s.i. on continuous duty.

Cyanamid of Great Britain, Ltd., of Bush House, Aldwych, London, W.C. 2, issue some notes on AM-9 chemical grout, which has been used successfully to seal porous sandstone at depths below 2,000 ft. during shaft sinking at the Monkton Hall colliery in Midlothian. Engineers of the Cementation Company working on the project, it is stated, discovered that conventional grouts were unsatisfactory in some of the sandstone bands encountered. Seepage continued through the rock and there were difficulties in completing the shaft lining. They turned, finally, to AM-9 Grout, a dry white powder which, mixed with water, can be applied in an ordinary solution which will penetrate any porous mass. Dissolved in water, with a suitable catalyst, it is injected under pressure, the type of catalyst used controlling the gelling time, which can vary from a few seconds to several hours. The viscosity of the solution remains substantially the same as that of water until just before the gelling starts. At the Monkton Hall shaft the water flow into the sump from the open holes drilled to 60 ft. depth was 144 gall. per min. before injection. When the shaft had been sunk through the full depth of the bed of sandstone the water make from the wall was roughly 40 gall. per min. Of this it is estimated that about two-thirds came from above the sandstone bed or from the upper part of the bed into which the injection stand pipes were fixed and which did not receive treatment. It is pointed out that, while inflow has been reduced to about one-tenth, the volumes of inflow after excavation are from the full bore of the shaft in the porous rock, while the inflow from the drilled holes was from pipes of 2 in. diameter. It is likely that the flow resistance of the sandstone has been increased by AM-9 treatment in greater measure than the figures of inflow suggest.

Libu Shovel Co. AB., of Stockholm, represented in this country by the Libu Shovel Co. (Great Britain), Ltd., of Amersham Common, Bucks., announce that their patent open-sided buckets for Caterpillar Traxcavators are now made in models suitable for light materials or high specific gravity rock or ores. Note of the design of these useful buckets was taken in the MAGAZINE for June, 1959, and reproduced here is a photograph of two such machines simultaneously loading a heavy truck at St. Patrick's Copper Mines, in Wicklow, at a rate of 400 tons per hour. In addition, the company states, the buckets are suitable for the new Series H Caterpillar Traxcavator loaders and also for the new wheeled tractors. The new models, which are easily interchangeable with standard equipment without any alteration on the tractor, have a built-in and guarded side dump cylinder which permits maximum unloading height and since the bucket can tip to either side, as well as forward, manoeuvring time for the tractor to get into dumping position is reduced. The cutting out of unnecessary travel and turning increases production per hour and makes a saving in fuel, labour, and engine wear, track life, etc. The 955 Series H tractor now available from Glasgow with a Libu 2450–55E bucket will load 117 loose cu. yd. per hour and the same tractor with the 2700–55E bucket for light material will load 183 loose cu. yd., it is stated. The bucket, which until now has been mainly sold in Europe and Africa, is to get a worldwide sale, Libu companies having recently been formed in Australia and the United States.

Associated Electrical Industries (Rugby), Ltd., of Rugby, in a recent announcement state that the Electronic Apparatus Division has devised a new system of "Clearcall" carrier-frequency communication which provides an excellent two-way loud-speaking conversation channel for the locomotive driver and despatcher. The equipment, which is certified in accordance with Mining Regulations as intrinsically safe and flameproof, operates

as follows: Speech signals are transmitted by a modulated carrier-frequency in the 100-kc/s region along an aerial wire which is strung along the roof of the mine road. The locomotive carries a receiver with a loop aerial which picks up the signal from the wire in the same manner as a radio receiver—*i.e.*, without mechanical contact—and it is then amplified, demodulated, and passed to a loud-speaker in the cab. By similar means a transmitting circuit enables the driver to acknowledge his despatcher's instructions and provide information as necessary to promote efficient working. The microphone and loudspeaker may be separate units or a single loudspeaker-microphone unit can be employed.

For N.C.B. installations all the transceivers in the system are tuned to the same frequency so that instructions and information are received simultaneously by all drivers. Equipments can be supplied, however, for operation on separate frequencies if desired, so that sectional working can be achieved. This facility may well be preferred for overseas installations and for this a non-flameproof version is available. The "Clearcall" equipment on the locomotive is operated by a transistor-inverter power pack driven from miner's cap-lamp batteries mounted in an intrinsically-safe container. The static equipment is normally connected to the mine power supply at the selected operating point of the railway system.

More recently the company secured an order for electrical equipment for a new rod-mill from the Broken Hill Proprietary Co., Ltd., Australia. The mill will be driven by d.c. motors ranging in output from 600 to 2,500 h.p. and the total power available will be 17,700 h.p. Mercury-arc rectifiers, rated in all at 13,000 kW, will supply the mill motors. Switchgear, control gear, auxiliary drives, and other equipment are included in the order.

RECENT PATENTS PUBLISHED

A copy of the specification of the patents mentioned in this column can be obtained by sending 3s. 6d. to the Patent Office, Southampton Buildings, Chancery Lane, London, W.C. 2, with a note of the number and year of the patent.

11,278 of 1956 (837,595). DORR-OLIVER, INC. Multitray clarification apparatus.

22,746 of 1956 (836,424). STAMICARBON N.V. Separation of free liquid from masses of loose solid materials.

39,212 of 1956 (836,039). SOC. GEN. METALLURGIQUE DE HOBOKEN. Concentration of mineral substances.

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Selected Index to Current Literature

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